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EDITORIAL NOTES.

Half-Year's Results of the Gas Light Company.

WHEN the expected happens, no one is surprised. It has happened in the case of the working of the Gas Light and Coke Company during the past six months. At the last meeting of the proprietors, the Governor (Mr. John Miles) gave warning when he mentioned that the Board had had to enter into contracts for coal and oil for the then coming winter at increased prices, and when in the same connection he refrained from speaking as to the prospects of residuals. In the circumstances of still higher prices for all the raw materials, something in the nature of a miracle would have had to occur for the past half year to maintain the same financial appearance as did the preceding war ones. But though the expected has happened, it is not so bad as it might have been in the prevailing conditions and uncertainty, which is about the most constant companion that one has in connection with the operations of a gas undertaking to-day—anyway, so far as materials, freights, some part of the residuals, and military requirements in respect of men are concerned. Residuals have fortunately, backed by an increase in the sale of gas (the benefit of which has been discounted by the compulsory lowering of the price of gas south of the Thames to 2s. 8d., following, as required by the Legislature, the step taken in this direction by the South Metropolitan Gas Company), brought in the half year heavy relief to the financial situation, and thus have restricted to £129,004 the inroad upon the balance brought into the half year (£480,512). This leaves £351,508 to be carried forward. In other words, the sum of the capital charges and other obligations of the Company was not made in the half year, as figures will show. The balance transferred from revenue to the net revenue account is £434,427, or less by £169,887 than a year ago. Interest and dividends on debentures, preference stock, and temporary loans, with £5000 for the redemption fund, amount to £220,848, which leaves £213,578 available for ordinary dividend. As this, (at £4 4s. p.ct. per annum) requires £342,582, the shortage in the half-year's profits is the before-mentioned £129,004. The position illustrates the advantage of a good balance forward, which has to be of substantial amount in the case of a company carrying on operations of such magnitude as the Gas Light and Coke Company.

In their report, the Directors dismiss an increase of £341,324 in the cost of raw materials for manufacturing purposes with the remark: "Freights for coal and oil are still "at an abnormally high figure, and most seriously influence "the Company's working." The total cost of raw materials, omitting shillings and pence, was £1,403,892, as compared with £1,062,568 for the corresponding six months of 1915. But some 64,437 tons more coal were used, which made the total 893,477 tons, to which not even a lessened consumption of 2,077,487 gallons of oil (which brought the use down to 5,992,586 gallons, against 8,070,073 gallons in the comparative half year) supplied an offset, in view of the considerably heavier cost for the smaller quantity of oil. Besides, the gas production was increased by 505,389,000 c.ft., which made the total output 14,361,788,000 c.ft. These figures show that the whole of the augmented cost of materials must not be attributed to higher coal prices, though they predominate in producing the increase. Coal, costing £1,175,992, was responsible for an addition of £288,729, which is a very heavy sum having regard to the amount of the additional tonnage mentioned. Oil entailed an expenditure of £158,830, or £43,135 more, despite the reduction named in the consumption. Coke, &c., used in the manufacture of carburetted water gas cost £69,070, or £946c more. Most fortunately, residuals, bringing in £840,584, gave the splendid additional set-off of £240,522; the income from this source in the December half of 1915 having been £600,062. Had it not been for this increase, the Board would have had very different feelings in appearing before the proprietors, though in these times entirely helpless in directing the course of outside markets. Deducting the £840,584 that was received for residuals from the total cost of £1,403,892 for manufacturing materials, we have a net charge of £563,308, which is £100,802 more than in the corresponding period of 1915, and which is a sum over which there is cause to be thankful, having in view the whole of the circumstances. Special mention should be made of coke and tar and tar products for their grand contributions to the enlarged income. In yielding £496,307, coke gave £127,208 more, with a sale increased by 60,435 tons, to 434,225 tons. Tar and tar products, in producing £178,209, gave £95,448 more. Ammoniacal liquor and sulphate of ammonia, in returning £139,162, added to the income by £18,861. Breeze, on the other hand, yielding £26,905, was down £996 in its contribution.

Income all through exhibited a more benignant spirit than outgoings. There was an increase in the sale of gas amounting to 1·4 per cent.; and the revenue from the business in gas was £1,914,800, or (notwithstanding the 2d. dropped per 1000 c.ft. in the southern area) £16,084 more. The increase in the sales is practically all due to private consumption. The quantity sold for all purposes was 13,083,677,000 c.ft., which is 177,920,000 c.ft. more than in the second half of 1915. Private consumption, in accounting for 12,840,703,000 c.ft., contributed to the increase 177,772,000 c.ft., while public lighting and under contracts, in using 242,974,000 c.ft., only contributed 148,000 c.ft. additional. Still, in the circumstances, the last-named figure is also satisfactory. In this connection, there may be comparison with the last December half year (1913) unfettered by war conditions and military restrictions in regard to lighting. In that half year, there was a total sale of 13,357,753,000 c.ft. of gas, in comparison with which last half year showed a reduction of 274,076,000 c.ft. But a still more satisfactory comparison is supplied by the figures for private consumption. In the second half of 1913, the private sale was 12,887,400,000 c.ft., or only 46,697,000 c.ft. more than in last half year—notwithstanding current shop-lighting restrictions, shorter hours of business in licensed premises, and economy in lighting in households. This indicates that private consumption is regaining in other ways what restrictions in certain uses have deprived it of. This is not surprising when the Company can report an increase of 5641 in the number of consumers in the six months, and of 37,834 in the number of gas-stoves sold or let on hire—the corresponding figures being 5367 and 31,044. Further testimony to the expansion of the basis of private business is found in the increase of the rental for meters, stoves, and fittings, by £7802, to £257.524. All this is highly satisfactory, especially when it is remembered that the figures apply to war time.

The total income for the half year was £3,019,592—an increase of £265,085. But the expenditure advanced, by £434,972, to £2,585,165, which, as previously seen, depre-

ciated the transferred balance by £169,887—viz., £434,427 against £604,314. The £434,972 advance in expenditure is quickly accounted for when it is seen that the total increase in manufacturing charges (£1,875,756) is £421,388, of which the gross costs of gas-making material account for £341,324, and that the distribution charges, amounting to £385,764, were higher by £12,264. The charges for labour have again increased, and so (no proprietor will regret this) have the allowances to employees on active service.

Briefly regarding the manufacturing experiences, of the 14,361,788,000 c.ft. of gas made in the half year, 3,064,531,000 c.ft. were carburetted water gas, which gives the make of coal gas as 11,297,257,000 c.ft. The quantity of coal carbonized being 893,477 tons, the average production per ton was 12,644 c.ft., which is rather less than the two preceding half years. In the December half of 1915, it was 12,791 c.ft.; and in the first half of last year, it was 12,733 c.ft. High freights and short supplies of oil have told their tale in the make of carburetted water gas—the production having been less than in the corresponding period by 187,453,000 c.ft. But this alone does not account for the considerable reduction of 2,077,587 gallons in the total quantity of oil used—5,992,586 gallons, compared with 8,070,073 gallons. Working out the figures, there has been a saving of oil over the whole make of carburetted water gas of 0·53 gallon per 1000 c.ft.—that is to say, an average of only 1·95 gallons have been used, compared with 2·48 gallons.

The report of the Directors contains matters of interest which are not noticed in this article; but more will certainly be heard of them when the Governor addresses the proprietors next Friday week.

Calorific Power Standards and Changes in Detail.

LOCAL authorities who have been making applications to the Local Government Board under the Gas (Standard of Calorific Power) Act will be interested to learn that the terms in which an Order has been issued to the Leeds Corporation are, with slight modifications, similar to those in the Sheffield Company's Order—see Nov. 21, p. 382. The modifications had prior exemplification in the Lea Bridge Company's Order referred to last week (p. 165), and repeated in the Cheltenham Company's Order noticed this week, both of which emanated from the Board of Trade. This uniformity between the prescriptions of the two Departments is what was expected; inasmuch as it would have been peculiar to have had differences in the main conditions as between local authorities and companies. Though anticipated, it is satisfactory to have the testimony in print of the two departments being in final practical agreement on all points, though in respect of details there might have been some temporary variation of opinion.

The chief cause for satisfaction is that this Local Government Board Order increases the difficulty of gaining ground on the part of those local authorities who are still showing some hostility, and who think that they could improve on the evidence that has already satisfied the two Departments, and so show that the limitations put upon gas undertakings should be still further tightened, and that consideration measured variously according to the local view—which is in this matter more or less incompetent—should be exacted from the gas undertakings concerned. While some of these local authorities are preferring this and that, the members of most of them could not, if questioned, possibly give any intelligent explanation of precisely what it is they are suggesting. Some of them would have to call to their aid a reference book to inform themselves as to what really constituted a B.Th.U., or if asked to explain there and then what was meant by a minimum pressure of 15-10ths, not a few of them might be at a loss for an answer. A case came before us the other week when members of a local authority, in meeting assembled, held forth on the necessity of trying to get a higher calorific value standard than 500 B.Th.U.; but, towards the end of the discussion, it transpired that no one in the Council knew what was the calorific value of the gas at present being supplied. Comment would, indeed, be superfluous. But we will give most local authorities their due, that they appreciate that what gas undertakings are doing for the country to-day must cause some amount of degradation of the gas in respect of illuminating power; and it is dawning upon them that the heating power is only depreciated to a very modest extent. There may also be, in the circumstances, a moderate increase in inert constituents; but there ought not to be a considerable one. However, local authorities who think, on unsubstantial grounds, that they ought to have something more than the conditions on which changes are being made in the qualitative standard, will see that other equally important and perhaps more intelligent local authorities who own gas-works do not agree with them, and that the Local Government Board, through the Leeds Order, have endorsed this disagreement.

In the matter of testing, local authorities are in a different position from gas companies. In the case of the latter, the local authorities are the supervisors who ensure that there is compliance with the statutory requirements. In the case of local authorities whose mains do not run into the areas of inquisitive neighbouring authorities, they are their own sole supervisors of the degree to which gas quality and pressure shall conform with the legislative stipulations. This condition receives due emphasis in the Leeds Order. Those gas companies who have already received Orders from the Board of Trade are permitted to try to effect an agreement with the local authority as to the apparatus and mode of testing that shall be adopted in order to give the gas credit for its maximum heating duty. Failing such agreement, there must perforce be adoption of the calorimeter and conditions of use prescribed by the Metropolitan Gas Referees. The Local Government Board are evidently of opinion that freedom in the choice of calorimeter and conditions of use should not rest with a local authority with no one with whom to make agreement, and so they have placed upon them the obligation to use the instrument and conditions prescribed by the Metropolition Gas Referees, no matter whether or not something is, or may hereafter be, available that will do greater justice to the gas. Such a stipulation ought to be safeguarded by a power of appeal to the Local Government Board, who might be authorized to refer the question to an arbitrator.

The only other material variation in the Leeds Order, and in the Lea Bridge and Cheltenham ones issued by the Board of Trade, is found in the right to a quinquennial application for revision up or down of the calorific value standard. The Sheffield Company's Order fixed the right of application to within month after the expiration of five years, and, if not then acted upon, after the expiration of any subsequent period of five years. We think on balance of considerations *pro et con* that this periodic condition was right, in view of the fact that gas undertakings do not want hanging over them indefinitely the probability of changes being made at any time which might affect coal contracts and manufacturing practices. On the other hand, the five-yearly wait after the termination of the first five years (most of which will be years of uncertainty, and during which gas undertakings will not want to be disturbed) might in some instances be a positive disadvantage. In the cases of both Lea Bridge and Cheltenham, the Board of Trade have provided for applications for revision being made "at any time" after the expiration of five years; and the Local Government Board have also liberated revision applications from any fixed period after the termination of five years. The constantly open door to applications for revision after five years is therefore apparently a fresh and agreed determination on the part of the two Departments. In the Sheffield Order the company and corporation were specified as the parties to make revision applications. In the Orders now being issued to companies, the company or any body or person who may appear to the Board to have a substantial interest in the matter may make application. Converting "company" to "local authority," the same condition appears in the Leeds Order. Furthermore, applications for revision may now include the prescription for minimum pressure—15-10ths in all the Orders—as well as the standard of calorific value.

The Chemist in Gas-Works Development.

THERE is much in the lecture that Prof. G. G. Henderson delivered last Saturday week to the Scottish Junior Gas Association of which men have heard before who are living closely in the work and operations of the gas industry, and who are studying daily the economics of their processes and results. There is, however, one feature of the lecture over which there cannot be too strong insistence, and that is as to the extensive region that the industry presents to the chemist, and the need for chemists to take a larger share in its development. Custom is a hard nut to crack. But the long reign of the idea as to the position of the chemist being properly an appendix to the engineering staff, with

pay suitable to the inferior place, is fast coming to an end, and his destined office is that of a collaborator where the development of an undertaking is prosecuted on sound lines. Why, we are asked, has the chemist showered on him just now so much attention? What has he done to merit it? The answer to the first question is because the time is particularly opportune; and that to the second one is that the chemist has not been allowed much opportunity in an industry which has in the main been, from the very beginning, developed by the engineer, who has built the structures for processes that almost from the initial stages to the end are chemically based, and every extension of which processes claims more and more chemical supervision and control in order to secure and to maintain efficiency, and bring about development. But while the engineer has designed and built the structures, we are not going to admit that chemical assistance has been rigidly kept at arm's length.

The belief that this has been the case seems to be indulged in by Prof. Henderson when speaking of the development of vertical retorts. He appears to think that the fact that the modern type of retort gives a gas that is well suited for modern purposes is quite accidental, and not derived from scientific organization. Having just previously spoken of the vertical retort, we take it by "modern type" he means that form of retort. The development in regard to this retort was "mainly from the point of view of the engineer;" and "the change in the chemical reactions had been lost "sight of." Bueb was chiefly responsible for the development of the Dessau system; and Bueb was more chemist than engineer. William Young, who took such a very keen interest in continuous carbonization of coal for gas making, was undeniably a physicist and chemist of the first rank. Step by step in the development of these retorts the work of other chemists was brought to bear in guiding as to design, with the view of realizing low fuel expenditure and good results in products, primary and secondary. In the development of both the intermittent and the continuous retorts, the road to the success achieved was a long one. We freely admit that in both systems there are advantages and disadvantages; but we should much like Prof. Henderson to be somewhat more explicit, by taking the types of vertical retort, and, by comparison or in any other way, point specifically to the places where he thinks greater working efficiency could have been derived through the agency of the chemist whose work he believes was absent in their development. His criticism might then be more valuable. At any rate, the systems have been in operation for several years at works of some magnitude, under the daily observation of chemists; and we do not remember any particular criticism emanating from them which has had a constructive or an improving tendency. At the same time, there is not the slightest question that our carbonizing operations require exact and detailed chemical and physical exploration from their alpha to their omega.

Physico-Chemical Considerations Affecting Benzol Recovery.

IT was not long since that some friends of the coking industry were advocating a thorough scientific research into the problems involved in the recovery of benzol by the oil-washing of gas. The desire and advocacy can be supported by all interested; but it will be a matter of some satisfaction to those who have long been engaged in extracting benzol from coke-oven gas to find the new-born enthusiasm in the gas industry in connection with the question has led some of its own chemists to engage in a closer investigation of the problems than has hitherto been given to them. They have come-up against difficulties in the application of oil-washing to town's gas; and they are not satisfied with the practice that has not been refined by investigation and experiment, under which practice efficiency is short of what it should be. The fact of the matter is that there has been little study of this particular process from the physico-chemical standpoint; and known theories relating to liquids, vapours, and gases have not been applied to direct and to govern practice. Birmingham has now given us a contribution which will start off the investigators on to new lines of research in this connection, and cause a departure from the experimental work which goes no further than trying new conceptions in practice, and determining propriety and efficiency by comparative results.

The author of the contribution is Mr. T. F. E. Rhead, M.Sc., of the Central Laboratory of the Birmingham Gas Department. He takes us into the background of benzol-recovery practices, and furnishes extremely useful information, especially with reference to temperatures, the viscosity of the wash-oil, and much else, the value of all of which can best be immediately appreciated by those who, like Mr. E. W. Smith (the Chief Chemist of the Department), have been working with him, but will be more widely appreciated as experiment based on this work proceeds in other quarters. The paper deals with creosote; but those who study it will not overlook what Mr. Smith had to say regarding gas oil as a washing medium, which oil he thinks, at even the present extraordinarily high price, it would probably pay to use. However, whatever the character of the wash-oil, quantity, temperature, time, and contact are all important considerations in realizing efficiency. Mr. Rhead shows us the influence of these factors, and discusses the methods of application. The temperature of the wash-oil has large effect not only on the amount of the benzol recovered, but upon its analysis. Providing that the creosote keeps sufficiently fluid, the efficiency of the washing is improved by using the wash-oil cold. Increasing the intimacy of contact between the oil and gas enhances efficiency; and washers on the spray or atomizing principle appear to offer the best field for development in this direction. But perhaps the most interesting part of the paper is that which treats of the importance of the viscosity of the wash-oil, which is suggested as the test to follow in preference to gravity. On this point, and to obtain Mr. Rhead's recommendations as to the specification for a good creosote, ready information can be obtained from the conclusions set out at the end of the paper; and further explanation is found in Mr. Smith's observations in the discussion. The only remark that need be made upon the subject of the importance of viscosity is that the degree of importance is no doubt affected by the type of washing plant employed. However, having been induced by the conclusions at the end of the paper to study the body of it to ascertain the roads by which Mr. Rhead arrives at his conclusions, readers who have not made similar previous study will realize better than before how the "physical properties and composition of the "wash-oil plays a vital part in crude benzol extraction."

Maximum Product in Carbonization.

"How can we operate our ovens so as to obtain the maxi-"mum yield of products?" That is a question to which Mr. D. V. Hollingworth addressed himself in a paper read before the Western Section of the Coke-Oven Managers' Association; and it is one which, with the conversion of "ovens" to "retorts" or "producers," is of importance to every carbonizer of coal. To give an answer satisfactory to all carbonizers, there should be devoted to the question a thorough scientific research with all forms of carbonizing plant, and then it would be only possible to educe general principles from the results; for unless all the conditions of plant are alike, and especially the character of the coal the same, there would be variations in result with the treatment of the latter on fixed lines. The whole question of carbonization resolves itself into working with the object of making the largest aggregate value in products per ton of coal carbonized; and the maximum yield of the primary product of quality according to requirement does not, of necessity, mean that the largest profitable result is being secured per ton of coal carbonized. In the gas industry, we are confined more or less to ordering our working in the first instance so as to produce gas of a given qualitative value; but this does not mean that the rest of the products should take "pot luck," nor that working should be conducted with neglect of the collateral influences of fuel economy and plant maintenance. What we have here is a very large question which has never received proper investigation.

However, there are a few general principles that Mr. Hollingworth thinks might advantageously be applied to practice in coke-ovens. In the first place, the coal should be worked as fresh as possible, in view of depreciation of the coking properties by exposure and oxidation. There should be careful elimination of pyrites and other foreign substances, as well as scientific control of the washing of the slack. The moisture permitted to remain in the slack should be, as near as possible, 9 p.ct.—rather above than below would be better. Temperatures should be carefully

controlled; and there should be speedy removal of the products from the ovens. These are all generally applicable rules. But it is necessary to go beyond them into the more scientific realms of the question, in order to make the utmost out of the raw material used. And coal carbonizers have larger opportunities now than ever. It is time that the gas manufacturer cleared from his mind the idea that his predominant duty is to make from a ton of coal the maximum amount of gas, and that there was abandonment of the old parrot-like cry that "We are gas makers first." The quality and production of the secondary products have a very important bearing on the price of gas; and therefore to them equal technical attention should be paid. By so doing, the gas engineer is serving well the primary function of a gas-works. And the same in the coking industry. While coke is the staple product, the secondary products should not be treated as mere hangers-on, but as contributing their share to the general economy and profit of the whole system.

A particular point is made by Mr. Hollingworth of the production of ammonia. In this connection, he refers to the influence of temperatures and moisture upon the ammonia yield. In gas-works, where practically dry coal is used, 20 to 25 lbs. of sulphate of ammonia are made per ton; in some gas-works (these are confessedly exceptions) up to 28 lbs. or so are realized. In coke-oven working, with 8 to 10 p.ct. of moisture in the coal, 30 to 35 lbs. are made; and in the Mond gas-producer, using large volumes of steam, up to 80 lbs. But here we see how the balance has to be held between the products. In the first two systems, the ammonia production has to be so ordered as not to affect detrimentally the primary products. The coking system would break-down in its main purpose if (to gain a greater yield of ammonia) a larger amount of moisture was admitted with the charge than a little above the 9 per cent. that Mr. Hollingworth mentions, or (let us put it) at the slightly less than 12 per cent. advocated by Mr. G. T. Purves—it would break down through the lag produced in the carbonization, which would reduce the coking capacity of the plant, and the coke itself might be badly affected. In gas-works operations, it is conceivable, now that the calorific value standard is taking the place of the illuminating power one, that there may be greater liberty in the practices so as to increase the ammonia yield. We shall see.

The question is also discussed as to the effect on the production of ammonia of the moisture mixed with the slack used for coking. Mr. Hollingworth opines that the hydrogen forms a protection to the ammonia in coming into contact with the red-hot coke. It must not be forgotten that the ammonia is diluted with other gases; that its destruction starts at (say) 900° C.; and that this increases with rising temperatures. We have to remember, too, that what Mr. Hollingworth calls the carbonizing temperature is not the temperature existing throughout the charge nor throughout the period of carbonization; but from the outer to the inner part of the charge it varies, and is gradually ascending during the period of carbonization. So that the protection theory does not appeal with the force that Mr. Hollingworth would apparently desire that it should. In fact, he himself quotes temperatures, showing their influence on the yield of ammonia, which indicate the largest yield at 800° C., which precedes the temperature at which destruction commences when the protection would be required. In the address by Mr. Purves already quoted, it was stated that there appears to be a relation between the yield of ammonia and the ratio of hydrogen to methane. He also reminded that Tervet has suggested that hydrogen acting on red-hot coke may play an important part in increasing ammonia; while Burgess and Wheeler have shown that during the portion of carbonization at temperatures between 750° and 800° C. there is a large and sudden increase of the hydrogen evolved. Therefore at these temperatures the ideal conditions are presented for the Tervet reaction. Of course, all these deductions from experimental work are governed by conditions; for the formation of ammonia has its maximum at different temperatures from different coals, and the nature of the nitrogen compounds in the coal also causes some notable variation.

However, apart from any differences of opinion that there may be as to conclusions, Mr. Hollingworth does good service in investigating and calling attention to the problems surrounding the question of the realization of the most profitable over-all yields, having regard to the maintenance of efficiency in respect of the primary product.

Vitality of the Gas Industry.

The remarkable vitality of the gas industry has been proved by [omitting non-statutory concerns] its 209 p.ct. increase in gas sales since the first Electric Lighting Act was passed up to the year preceding the war. Even the war does not curb its power of expansion, save in districts with fixed limitations. Two pieces of intelligence published in last week's issue attest this condition; and at least one of them may be, in the crowd of other items of nterest, overlooked without special mention. In welcoming the members of the Yorkshire Junior Gas Association last Saturday week, Mr. W. B. Leech, the Engineer to the Leeds Gas Department, made a striking statement, which showed that, during the past three years, the development of the use of gas-furnaces in the city has resulted in a consumption of gas which has just about counterbalance the loss in the sales owing to the lighting restrictions, including—we take it—the Summer Time Act. This speaks of a good increase being shown when peace (with which we have for so long been strangers) again floods the world, and when the street and shop lights will all blaze out again, and there will be a settling-down in our households to regular habits of gas-consuming. The exact figures as to furnace consumption are: 1914, 5¾ million c.ft.; 1915, 48 million c.ft.; 1916, 156 million c.ft. This is a notable flight for such a short period as two years—war years though they be. The second piece of testimony was from Manchester, in a report by Mr. Frederick A. Price, the Superintendent of the Corporation Gas Department. He showed that for the past nine months, there had been an increase of 4·6 p.ct. in the day consumption—8 a.m. to 4 p.m.—but a decrease in the night consumption of 9·89 p.ct. Over the whole consumption, the decrease was 3·69 p.ct. This, with the enlargement of the number of gas-consuming appliances, indicates how the day load is working to fill up the valley in output caused by compulsory circumstances. No doubt the low temperatures of the past few weeks will have helped to still further narrow-down the percentage falling-off.

Vanishing Excuses for Coal Shortage.

The facts accumulate which show the chimerical nature of the excuses at one time made, in the interests of the coal owners and factors, for the so-called shortage of home supplies of coal, which was one of the grounds for high prices, and for certain other manœuvres that had financial advantage for the coal proprietors. We have seen how, in addition to the work of the Coal Exports Committee, want of shipping and high freights have affected sales abroad, and have left coal begging for custom at the pits. We have heard, too, of certain collieries working short time, because they could not get rid of their full production. Now there is about as complete a retractation as the Government could possibly furnish of the idle talk that there has been in the past on this subject. It was announced last week that, in view of the urgent needs of the Army and of the reduction in the export of coal and economies in its use at home, a certain number of men could be released at once—"at once," be it marked—from mines for military service. If the old excuses for the so-called shortage of supplies were actually true, then the situation has changed with remarkable rapidity, and changed, too, at the very apex of the peak of the winter's coal-consuming load. The classes of men whose exemptions are cancelled are named in the announcement. They are, in the first place, men who entered the service of the mining industry after Aug. 14, 1915, and unskilled men employed on the surface; and those of them who are medically fit will be called up for service.

De-badging Habitual Absentees.

The best point, however, about the announcement is the decision as to those lazy individuals who habitually indulge in "avoidable absenteeism," and are militarily fit. Their badging was for the purpose of securing their whole, and not merely part, service for the country in the mines. The announcement states that, in accordance with the general policy of the Government, adopted on the recommendation of the Man-Power Board for all certified occupations, the question of continuing the exemptions of men who have persistently worked short time without reasonable cause, and so failed to give the national service for which they were exempted, will be considered by the Colliery Recruiting Courts. This points to de-badging the unpatriotics, and calling

them up. No one will regret this but the men themselves; for if they are too lazy to work full time in the mines in such times as these, they will find the work of the trenches a bit arduous. However, they have courted the position in which they now find themselves.

Industrial Uses of Gas.

Roanoke (Va.) is a city with a population of about 50,000—and evidently a very live Gas Company, whose Manager (Mr. H. H. Dunn) has been "reporting progress." After stating that practically every hotel and restaurant in the place possess gas appliances, that the Company are removing alcohol from beer with gas, and that gas is employed in about forty cases to satisfy the law requiring that all glasses used at soda fountains should be sterilized before serving, he proceeds: "We are roasting chestnuts on the street, run gas to peanut and popcorn wagons, and machines singeing chickens, heat water in baptismal tanks in churches, and have at last broken into the big industrial plants, and are getting a chance at the tempering of tools, brazing, and tinning. We are now working on a 21 ft. long rod-heating furnace for rivet making, in which the estimated gas consumption will run over 1,000,000 c.ft. per month." Are there any new suggestions here which will add to the "thousand-and-one" uses of gas? The Consolidated Gas Company of Baltimore, too, in addition to installing at a tungsten steel products works gas-fired equipment with specially designed burners for the pre-heating of the ladles and moulds into which the hot metal is poured, have supplied three furnaces to a firm manufacturing one-piece bifocal lenses, for moulding and annealing the curved lens. The latter is the first installation of its kind in Baltimore.

PERSONAL.

Mr. J. H. NOBLE has been appointed Engineer to the Chester United Gas Company, in succession to Mr. J. C. BELTON.

The position of Engineer and Manager of the Gorse Hill works of the Swindon United Gas Company, applications for which were invited in the advertisement columns of the "JOURNAL," has been filled by the appointment of Mr. THOMAS SHADBOLT, Assistant Engineer and Manager at the Kendal Gas-Works.

Among honours just conferred by the King upon officers of the Army, Surgeon-General Sir ALFRED KEOGH, Director-General of the Royal Army Medical Service, has been promoted to G.C.B.—a high distinction which he shares with Sir William Robertson. This is an honour which will prove gratifying to all who had the pleasure of meeting Sir Alfred when he occupied the position of President of the Society of British Gas Industries.

OBITUARY.

The death in action is reported of Herr MAX MAYER, Constructing Engineer on the staff of the Nuremberg Gas-Works, who had served as a temporary officer in the German artillery since the beginning of the war.

Intimation has been received of the death, on the 14th inst., of Mr. H. T. HICKMAN, of Stourbridge. His son, who succeeds him in the business with which his name has for so long been associated, is Brigadier-General H. O. D. Hickman, at present engaged on his military duties.

The death took place last Sunday week of Mr. JAMES MASON, for many years Manager of the Oakham Gas-Works. He was 66 years of age, and had for some time been a great sufferer from a malady of the throat, which ultimately proved fatal. A widow and grown-up family survive him.

It is reported that Mr. FRANK OLIVER, who, prior to taking up military duty, was Chief Clerk at the Ash Road Gas-Works of the Aldershot Gas, Water, and District Lighting Company, was killed by a shell on the 12th inst. Mr. Oliver was previously with the Mold Gas Company. This is the third ex-employee of the Company to lose his life in the service of his King and country.

Mr. Charles Carpenter, D.Sc., will be unable to give a Friday evening discourse at the Royal Institution, as arranged, for the 2nd prox.; and in his place Prof. C. S. Sherrington will deal with "Recent Physiology and the War."

A number of gentlemen have formed themselves into the Empire Resources Development Committee, having for its object the conservation and development of the resources of the Empire. The Chairman for the present is Sir Starr Jameson; and the members include Sir Henry Birchenough (who is on the Boards of the Imperial Continental Gas Association and the Continental Union Gas Company) and Mr. Rupert Gwynne.

THE GAS LIGHT AND COKE COMPANY.

Half-Yearly Report.

THE following is the report of the Directors of the Gas Light and Coke Company for the half year ended Dec. 31, which, with the accounts [some particulars from which are given below], will be presented at the ordinary general meeting on Friday, Feb. 9.

The accounts for the past half year show that, after providing for fixed charges, and setting aside £5000 towards the redemption fund, there remains a profit balance of £213,578. The amount brought forward from the previous half year being £480,512, there is a total available balance of £694,091, out of which the Directors recommend the payment of a dividend on the ordinary stock at the rate of £4 4s. per cent. per annum, which will absorb £342,582, and leave £351,509 to be carried forward to the credit of the current half year.

The sales of gas for the half year show an increase of 1·4 per cent. compared with the quantity sold during the corresponding period of 1915.

There has been an increase during the six months of 5641 in the number of consumers, and of 37,834 in the number of gas-stoves sold and let on hire.

Freights for coal and oil are still at an abnormally high figure, and most seriously influence the Company's working.

The number of the Company's employees now serving with the Colours is upwards of 3700, of whom several have been mentioned in despatches. The Directors much regret the casualties that have occurred among these gallant sailors and soldiers.

The Directors greatly regret to report that, owing to ill-health, Mr. H. Rayner has found it necessary to resign his appointment as Secretary of the Company. Mr. Rayner had held the position of Secretary for thirteen years, during which time and throughout the whole period of his forty-two years' service, he devoted himself wholeheartedly to the Company's interests. He carries with him into retirement the best wishes of the Directors and his colleagues for his restoration to good health.

The Court has filled the vacancy by the appointment of Mr. W. Beckford Long, who was Mr. Rayner's assistant for a number of years.

A Bill has been deposited in Parliament with the object of amending or repealing the statutory provisions which apply to the purchase of ships by the Company, conferring powers on them to hold the ordinary general meetings of the Company annually instead of half-yearly, and for other purposes. An extraordinary meeting of the proprietors will be held on Friday, the 9th prox., immediately after the ordinary general meeting to be held on that day, when the provisions of the Bill will be explained and (in compliance with Standing Orders) the Bill will be submitted for the approval of the proprietors.

The Court has been furnished by the several Engineers of the Manufacturing and Distributing Departments with certificates that all the Company's works and plant have been maintained in thorough efficiency.

JOHN MILES, Governor.

Horseferry Road, Westminster, S.W., Jan. 19, 1917.

The Accounts.

The accounts accompanying the report consist of the usual statements.

The statement of capital (stock) sets forth that the total paid-up is £10,413,480; added on conversion, £12,832,955—total amount authorized, £23,246,435. Deducting the amount redeemed, £270,770, the total amount of the Company's existing capital powers is £22,975,665. The statement of loan capital stands thus: Total paid up, £3,186,660; added on conversion, £1,618,190; unissued, £750,000—total amount authorized, £5,554,850.

The capital account shows receipts (with premiums, £1,688,958) to the amount of £29,469,473. The expenditure is shown in the following items:

Expenditure to June 30, 1916			£14,789,282 19 9
Expenditure during the half year to Dec. 31, 1916—viz.:			
Buildings and machinery in extension of works	151,125 13 7		
New and additional mains and service-pipes	5,494 5 6		
Do. do. meters	15,689 15 2		
Do. do. stoves	62,416 12 4		
		234,726 6 7	
		£15,023,009 6 4	
By depreciation of plant	£52,550 7 2		
„ depreciation of meters and stoves	64,717 0 0		
		117,267 7 2	
Total expenditure			£14,905,741 19 2
Nominal amount added on conversion			14,451,145 0 0
		£29,356,886 19 2	
Deduct amount of capital redeemed under Company's Act of 1903			270,770 0 0
		£29,086,116 19 2	
Balance of capital account			383,355 15 6
		£29,469,472 14 8	

The total of the net revenue account is £914,940, compared with £1,040,373 at Dec. 31, 1915. The balance applicable to the redemp-

tion fund and to dividend on the ordinary stock is £699,090; and the following statement shows how it is proposed to appropriate it:

December, 1915.			
£436,059	..	Net balance brought from last account	£480,512 6 4
358,427	..	Net revenue for the half year	218,578 8 11
£794,486			£699,090 15 3
5,000	..	Contribution to redemption fund	5,000 0 0
£789,486			£694,090 15 3
(£4 4s. 0d. p. ct.)		Dividend on the ordinary stock—	
£342,871	..	£4 4s. per cent. per annum on £16,313,430	342,582 0 7
£446,615	..	Balance carried to next half-year's account	£351,508 14 8

The three statements relating to the reserve, special purposes, and depreciation funds stood as follows on Dec. 31: Reserve fund, £78,139; special purposes fund, £331,886; depreciation fund, £84,265.

The following is the revenue account:

Expenditure.

December Half Year, 1915.		£ s. d.	£ s. d.
	Manufacture of gas—		
£887,263	Coal, including all expenses thereon	1,175,992 17 2	
115,695	Oil ,, less value of oil tar	158,830 11 0	
59,610	Coke and breeze used in the manufacture of carburetted water gas	69,070 19 0	
16,191	Salaries of engineers and other officers at works	16,312 8 10	
102,138	Wages	121,712 8 2	
11,576	Purification	14,577 16 1	
261,895	Repair and maintenance of works and plant, materials and labour, less received for old materials, £5871 12s. 7d.	379,259 7 11	
	Distribution of gas—		1,875,756 8 2
63,545	Salaries and wages of officers (including rental clerks)	68,343 6 7	
96,285	Repair and maintenance of mains and service-pipes, &c.	108,984 10 8	
92,755	Repair and renewal of meters	90,430 13 0	
107,379	,, ,, stoves	106,414 9 10	
13,536	Gas-fittings, including labour (automatic meter supplies)	11,591 4 0	
			385,764 4 1
29,037	Public lamps—lighting and repairing	..	25,752 19 5
	Rents, rates, and taxes—		
7,306	Rents payable	7,434 10 7	
172,511	Rates and taxes	176,267 11 2	
			183,702 1 9
	Management—		
3,750	Directors' allowance	3,750 0 0	
304	Company's Auditors	300 0 0	
10 274	Salaries of Secretary, Accountant, and clerks	9,167 13 8	
28,849	Collectors and cashiers	31,928 7 9	
5,587	Stationery and printing	6,481 4 9	
7,393	General charges	6,955 8 7	
			58,582 14 9
4,600	Co-partnership, for the half year	..	4,600 0 0
124	Parliamentary charges	..	578 6 3
486	Law charges	..	324 10 2
1,050	Charges *re* Quinquennial re-valuations	..	..
7,676	Bad debts	..	5,706 2 5
500	Depreciation fund for works on leasehold lands	..	500 0 0
27,136	Annuities to officers and workmen, including contribution to officers' superannuation fund	..	26,817 14 5
7,166	Allowances to employees on Active Service	..	8,330 8 2
2,787	Workmen's compensation	..	2,817 9 7
4,218	Company's Contribution under National Insurance Act, 1911	..	4,369 0 10
	Public officers—		
857	Gas Referees and Official Auditor	851 18 10	
634	Public testing-stations	511 2 5	
			1,363 1 3
2,150,193			2,585,165 1 3
604,314	Balance carried to net revenue account		434,427 7 10
2,754,507			3,019,592 9 1

Revenue.

December Half Year, 1915.		£ s. d.	£ s. d.
	Sale of gas—		
£1,851,195	Per meter at 3s. and 2s. 8d. per 1000 cubic feet	1,868,685 1 0	
47,520	Public lighting and under contracts	46,115 7 8	
			1,914,800 8 8
1,898,716			
76,744	Rental of meters	..	28,356 17 3
78,892	Rental of stoves	..	84,876 16 10
94,026	Rental of fittings	..	94,232 11 4
	Residual products—		
369 099	Coke, less labour, &c.	496,307 4 2	
27,901	Breeze, less ,, ,,	26,925 12 6	
82,761	Tar and tar products	178,209 5 8	
120,301	Ammoniacal liquor and sulphate of ammonia	139,162 14 3	
			840,584 16 7
600,062			
5,808	Rents receivable		6,458 3 5
199	Transfer fees		222 15 0
2,754,507			3,019,592 9 1

Statement of Coal.

—	In Store June 30, 1916.	Received During Half Year.	Carbonized During Half Year.	Used During Half Year.	In Store Dec. 31, 1916.
	Tons.	Tons.	Tons.	Tons.	Tons.
Coal	152,576	1,011,729	893,477*	2,805	268,023

* In addition to this quantity of coal, 5,992,586 gallons of oil have been used during the half year.

Statement of Residual Products.

Description.	In Store June 30, 1916.	Made During Half Year.	Used During Half Year.	Sold During Half Year.	In Store, Dec. 31, 1916.
Coke—tons	14,216	552,144	108,043	434,225	24,092
Breeze—tons	22,360	122,626	20,160	90,670	34,156
Tar, from coal only—galls.	2,164,910	8,715,216	8,480,452	89,978	2,309,696
Ammoniacal liquor—butts	21,651	240,487	226,297	..	35,841

Statement of Gas Made, Sold, &c.

Quantity Made.	Quantity Sold.		Total Quantity Accounted for.	Number of Public Lamps.
	Public Lights and Under Contracts (Estimated).	Private Lights (per Meter).		
Thousands.	Thousands.	Thousands.	Thousands.	
*14,361,788	242,974	12,840,703	13,274,825	44,570
†13,856,399	242,826	12,662,931	13,082,990	44,740

* Including 3,064,531,000 cubic feet of carburetted water gas.
† December half year, 1914.

The remaining statement is the balance-sheet, which gives the value of the stores on hand at the close of the half year as follows: Coal, £339,495; gas oil, £141,962; coke, £21,920; tar and ammoniacal liquor and products, £135,802; and sundries, £480,420. The figures this time last year were: Coal, £289,529; gas oil, £88,658; coke, £32,943; tar, ammoniacal liquor, and products, £146,133; sundries, £401,364.

SOUTH METROPOLITAN GAS COMPANY.

THE half-year's accounts of the South Metropolitan Gas Company show that the balance of net revenue account will enable the Directors to recommend the payment of the statutory dividend of £4 13s. 4d. per cent. per annum, and carry forward £33,659, which is somewhat less than the sum brought into the half year. Prior to the reduction in the price of gas, the dividend had descended, in the war period, to the rate of £4 8s. per annum. The shareholders have therefore the gratification now of receiving an additional 5s. 4d. per cent. per annum.

SIXTY YEARS AGO.

From the "Journal" for January, 1857.

Death of Dr. Ure.—It is our painful duty to record the decease of one so illustrious in the scientific annals of his country as Dr. Ure, whose death occurred on the morning of the 2nd inst., at the advanced age of 78 years. For more than half-a-century, this distinguished philosopher has been favourably known to the scientific world as the author of many valuable works upon chemical subjects, and as the discoverer of numerous useful processes still applied in the arts and manufactures of this and other countries. Commencing his truly characteristic and utilitarian career contemporaneously with the wonderful discoveries of Davy, Dalton, Gay Lussac, and Berzelius, Dr. Ure has the great merit of having given a tone and direction of usefulness to the labours of these illustrious men, which, more than perhaps any other circumstance, has tended to popularize the science of chemistry in Great Britain; and, unquestionably, no man of the present day can claim to have brought forward so large a number of pupils, distinguished by their world-wide renown, as he has done in the practical development of science applied to the use of mankind. To this extent, Dr. Ure stands not only unrivalled, but unapproached. With an instinctive appreciation of the value of truth, and a laborious industry almost superhuman in arriving at correct conclusions, this distinguished man has left behind him many evidences of the surprising power and precision to which chemical analysis may be brought, in the hands of its real professors.

Fate of Alderman Carr's Plate.—On Tuesday, the 30th ult., the service of plate which should have been presented to Alderman Carr was sold by auction, at the mart of Mr. Nicholson, in Sheffield. At their last general meeting, the shareholders of the Sheffield Gas Consumers' Company resolved that the sum of £100 be awarded to Alderman Carr, as a token of respect and esteem, on the part of the Company, and their gratitude for the services he had rendered the undertaking. The affair was left in the hands of the Directors; and that body of gentlemen having shortly afterwards embarrassed themselves in law transactions, appropriated the greater portion of the money for other purposes, and the resolution remained in abeyance for some time. At length questions were asked; and the Directors expended the sum of £30 in purchasing a small service of plate. This they wished to present to Alderman Carr in lieu of the £100 voted at the meeting; but, of course, he refused to accept it.

ELECTRICITY SUPPLY MEMORANDA.

CONSIDERING the after-war conditions of electricity supply, the managers of undertakings operating in districts destitute of large industrial organizations may well look with envious eyes upon those favoured with these potent factors in prosperity, for their presence means a large day load, which makes such business (at popular rates) as the intermittent supply of electric-cookers, shaving-pots, curling-irons, and the like, shrink into insignificance. The Sheffield electricity undertaking is one of those blessed with a wealthy industrial area; the only thing that the manager of the undertaking wishes, if he ever thinks selfishly, and not of the economic interests of the city and environs, is that he had not to compete with one of the lowest priced gas companies in the kingdom, also doing an extensive business in power and furnace heating. However, there is no reason why both undertakings should not reap progressively good harvests from the industries of the city. They are both of opinion that this is their fortunate lot; for as their recently promoted Bills have shown, both are asking Parliament for new works powers. The war has, of course, made a great difference to the industrial load of both concerns; but there is faith that the experience gained in munitions making will simply transfer the business now specially applying to the war to other manufactures which are carried on with greater regularity in peace times than they can be at present. This faith is certified by the Bills in Parliament. The proposed site for the new electricity undertaking is at Rotherham; and it has an area of 35 acres. This clearly indicates a cheerful optimism as to the future—an optimism accentuated in a statement made in the Council by Alderman Styring, Chairman of the Corporation Parliamentary Committee, when moving a resolution in favour of the Bill. Applicants, he assured the Council, are clamouring for more and more power. The steel industry is making large demands for steel furnaces; and he is under the impression that the demand for current for this purpose is going to outstrip in importance power and light. There are people who are of opinion that when the war is over, there will be a large subsidence in the demand for power. Alderman Styring is assured that the Electricity Supply Committee have given very careful attention to this view, as they do not want to embark on a large scheme which, in the course of a few years, might prove in the nature of a white elephant. They are, on the contrary, satisfied as to the industrial demand rapidly increasing.

Industrial Demand After the War.

However, in this matter, the utmost caution should be exercised, bearing first in mind the Electrical Engineer's (Mr. S. E. Fedden's) report last year on the financial condition of the concern; and the need for a faster liquidation of capital and larger protective funds. While he then showed that much had financially been left undone that ought to have been done, and the situation was not altogether a healthy one, there is this proposal to incur a tremendous outlay—and rightly, too, if the interests of the city require it—in putting down new plant. But, of course, it cannot be expected that progress will continue to be at the same rate as that which has taken place during the speeding-up of the local factories for the production of munitions. Much of the work for which there has been this demand will cease with the cessation of hostilities; and a considerable amount of (say) motive power will then be let loose to be absorbed in normal operations before any material progress can be effected in extending connections. The forced pace of progress during the war is well shown by statistics. With the close of last year, the electric-motors connected to the mains numbered 3915, representing an aggregate of 68,739 H.P. In 1915, the number of motors was 3423, aggregating 45,916 H.P.; and in 1914, the number of motors was 2971, aggregating 34,422 H.P. The 492 motors fixed in 1916, and their 22,823 H.P., constitute a record. In these figures there is evidence of the pressure of the war years. Deducting the 1914 figures from those for 1916, it is seen that no less than 944 motors were installed during 1915 and 1916, of an aggregate horse power of 34,317, which horse power was only short by 105 of the total of the 2971 motors fixed up to the end of 1914. This suggests that the munitions pressure has caused a demand for motors of considerably higher power than before the war; for the average horse power of the 2971 fixed up to the end of 1914 was only about 11·6, while the average of the 944 that were fixed during 1915 and 1916 was approximately 36·3. In regard to the electric-furnace business on which Alderman Styring looks with such confidence, the Department is (as recently stated in the "JOURNAL") supplying current to twenty furnaces, and has sixteen more on order for connection; the local output of the whole being estimated at 100,000 tons of steel per annum. In a review of the past year's trade in the city, it is stated that, in a number of cases electric steel has proved a reliable substitute for Swedish steel, and the extension of melting by electric means should lessen the city's dependence upon Swedish iron and steel products, which are scarce and dear. The scarcity and dearness may refer to the war period; and, if so, the competition of Swedish steel may later on be a factor to be reckoned with. However, the figures suggest that calculations as to prospects should not be too firmly fixed upon the experiences of the war years, during which the pressure for munitions and market conditions for material cannot be depended upon to be reproduced for productions after the war.

Calculating Prospects on War Conditions.

By this we are reminded of some information lately given by the "Electrician" as to the world's progress of electric furnaces, which information it had culled from the "Journal du Four Electrique et de l'Electrolyse." It mentions the particulars as being new facts which illustrate "the great impetus given to the construction of electric steel furnaces." It is stated that, since the outbreak of war, over a hundred installations are known to have been put in; and the total number in the world now approaches 300, or about twice the number existing in 1913. The United States is credited with constructing 50 last year, and this country 30 [these are the Sheffield ones] since the war began. Germany is said to have produced 130,000 metric tons of electric steel in 1915, as compared with 90,000 tons in 1914; and Italy is also making large additions. At a recent meeting of the Sheffield Society of Engineers and Metallurgists, the President remarked that electric furnaces had come to stay; but they must be supplied, by some means, with cheaper electric current.

Development of the Electric Furnace.

This claim for cheaper current for electric-furnaces is one that in this country it will be difficult to comply with under existing conditions if the business is to be conducted on a commercial basis, including all charges right away to capital and depreciation costs for the plant involved in the provision of the current. In a recent article by Mr. E. Kilburn Scott in the "Electrical Times," he, discussing electric furnaces, utilizes the figure of ⅛d. per killowatt-hour, at which he says "for many years electric energy has been delivered in this country to certain electro-chemical and metallurgical factories. The conditions under which this low charge has been made are not stated; but it must not be forgotten (especially in view of what the President of the Sheffield Society of Engineers and Metallurgists said as to still cheaper current being required than is now obtained for furnace work in that city) that it will be some years before electrical or any other constructional work can be carried out at pre-war rates. Capital, fuel, material, and labour will also continue to be dearer; and so cheaper current on a profitable basis is something that is very problematical. The only possible chances of it must be through a better utilization of coal, further development in machinery, and improved load. The object of Mr. Scott's article is to urge electrical engineers not to let fresh enterprise depart from this country to others where water power is available, on the false assumption that electrical energy can be produced by water-power at a lower rate than by modern generating plant, with a good load factor. We recently referred to this point [Dec. 26], and showed that capital cost of water-power-produced electricity is the weak spot in this method of generation. Norway and Niagara Falls are generally instanced, by those who do not know better, as presenting conditions against which we cannot compete. Mr. Scott points out that the cost of Niagara power is $20 per horse-power-year, which is about $26¾, or upwards of £5 10s., per KW. year. It is thus seen that Niagara power is really 20 p.ct. higher than electric energy contracted for in this country at the ⅛d. cited by Mr. Scott, although we doubt if much of it is sold at that price.

Water Power Generation.

$$\frac{0{\cdot}125\text{d.} \times 8760 \text{ hours}}{240} = £4\ 10\text{s. per KW. year.}$$

Though representing a competing industry, and though occasionally harbouring doubts as to the profitable nature of some electrical bargainings for the supply of current, we feel pride that there is something electrical in which we can beat our friendly Transatlantic rivals, just as in the case of gas we beat them in lowness of charge. It is a significant fact to which Mr. Scott points that, although the United States has still plenty of undeveloped water power, large electric generating stations to utilize coal fuel are constantly being erected and extended. Buffalo City, which is quite near Niagara Falls, finds it economical to generate electricity from fuel; and the new plant of the Acheson Graphite Company is not being built at Niagara near their present plant, but is at Buffalo, and will take current from a steam-power plant. If the American engineers find it advantageous to develop along steam-power station lines rather than harness water power which they have got, then we can do the same. Mr. Scott proceeds to talk of the gasification of coal, and the money-making bye-products, as a means of cheapening electrical production. In making a final appeal to electricians not to let new industries pass them through the water-power bogey, he says he is especially interested in this matter from the point of view of making air nitrates in this country; and in four years' persistent endeavours to get the industry started he has learned much as to the attitude of the chemical trade, especially what may be called the "factoring side." "Powerful interests have been and still are at work, opposing the introduction of electric-furnace products, and particularly nitrates made from air. However, we are possibly on the eve of developments which will be too strong for any opposition."

The proof of highest utility in any occupation in which gas and electricity indulge is the ability to meet all sorts of conditions—particularly the worst among them. Electricity suffers

Stranded.

Given an equal illuminating power at the source, gas has a larger penetrative power in fog than electricity; gas is often maintained, too, as a stand-by to electricity in the lighting of important premises, because of its greater reliability. Electricity is an admitted failure for the heating of rooms in the cold, austere weather such as we have been experiencing recently; while the day load of gas undertakings during the extreme weather makes flights that would distress the electrical man working without storage. For kitchen purposes, where foolishness or a childlike faith has led to the introduction of electricity for cooking, gas has often come in as the householders' friend. The daily records of work done on the district bear witness to this. And now the spectacle has been seen of steam-engines coming to the rescue of electric traction owing to electric conductor rails getting icebound, which prevented the shoes making contact. This was on Monday of last week, when London business men and women were anxious to begin the week well; but those who were placed at the mercy of electric traction in most cases failed to do so. We unfortunately met one of these belated arrivals, who perhaps was in one of those trains that had, due to immobility, to be victoriously tugged to its destination by the engine of one of its predecessors actuated by steam power. All but his tongue appeared to be frozen. However, it was much later in the day before the electric trains recovered their dignity, and then only by the aid of more favourable atmospheric conditions. At the meeting of the London County Council on Tuesday, it was mentioned that, between Jan. 1 to Jan. 19, there were fifty breakdowns of the tramway service, by which large numbers of workmen had been delayed in getting to their work in the mornings.

Cost of Electrically Heating Dwellings.

There has been more recognition lately in electrical circles of the tremendous handicap that, through its thermal infirmity, electricity possesses in the matter of house heating. The American "Electrical World" recently contained the results of some investigations by Mr. F. A. Osborn, which the "Electrician" sums up as follows: "The experiment was conducted in a typical dwelling-house on a practical scale; the effects being compared of a standard hot-air system, coal-heated, and a series of electric radiators, in some cases connected with a hot water heat-storage appliance. From these tests it is deduced that electricity selling at 0·29 c. (about ¼d.) per unit would be equivalent to heating by coal with the coal costing $7·75 (approximately 38s. 6d.) per ton." There is something wrong in one of the two last-named figures; but that does not matter much. As we look at the ¼d., our sympathy goes out to the competitor.

Illumination and Architecture.

Illuminating engineers should note that Mr. Jas. Nichol, of Greenock, in a communication to "Electrical Industries," maintains that the attempts at wiring design made by illuminating and consulting engineers without intimate knowledge of building construction are equally as unsatisfactory as the failures of architects with no knowledge of illumination and electrical requirements. There is something in that, judging from the unhappy experience of the lecture theatre of the Institution of Electrical Engineers. But then some illuminating engineers never would make architects; and some architects could never by any possible chance be moulded into illuminating engineers, just as some electrical engineers show a woful incapacity for anything but running generating plant, and this sometimes on the lines of high inefficiency, despite their achievements in as Prof. Armstrong would say) the "highest mathematics."

REGISTRATION OF BUSINESS NAMES.

MANY things have become essential for this country to do since the outbreak of war, with regard to which one wonders now how it is they were not done long ago. A case in point is the Registration of Business Names Act, which received the Royal Assent a few days before the end of 1916; and that this particular Statute should have been so long delayed seems specially strange, for the need of some such measure has long been recognized in the commercial world. Indeed, under the title of the Registration of Firms Bill, a start with legislation on the subject was made in 1914; and in the period which has since elapsed this Bill has been improved into the present Act, which will affect a very large number of business people.

Just whom it will affect, how it will affect them, and what they have to do, is made clear in a sixpenny booklet written by Mr. Herbert W. Jordan, and published by Messrs. Jordan and Sons, Limited, the well-known Company Registration Agents, of Chancery Lane, W.C. This sets out the requirements of the Act, which, it is pointed out, cannot be correctly described as a war measure, as its main purpose is to safeguard the interests of the commercial community and the public generally after the war. Broadly, those who must register are firms adopting a trading style which does not consist of the surnames of all the partners (either with or without christian names or initials in the case of individuals; individuals who do not trade under their own surname (either with or without their christian names or initials); and firms or individuals if, though not coming within either of the categories just mentioned, a member of the firm or the individual has at any time changed his name (except, in the case of a woman, consequent on marriage).

This summary shows briefly the application of the Act; but in view of the importance of noting the precise provisions of section I., Mr. Jordan proceeds to set this out in full, and to give separate consideration to each sub-clause. He explains that a firm does not come within the scope of the section if it has not a place of business in the United Kingdom; if it does not carry on business for profit; or if the surnames (with or without christian names or initials) of all the partners who are individuals and the corporate names of any who are corporations are comprised in the trading style, and nothing is added thereto. Examples are given to show the precise meaning of these exceptions. One section of the Act defines a firm as a partnership entered into with a view to carrying on business for profit, and consisting of an unincorporate body of two or more individuals, one or more individuals and one or more corporations, or two or more corporations. In the case of an individual, the words "carrying on business for profit" are omitted.

Where a business is carried on by a trustee in bankruptcy or a receiver or manager appointed by any Court, registration is not necessary; and it must be noted that the Act does not apply to limited companies or other corporations. Information with regard to limited companies is, of course, available at Somerset House, in accordance with the provisions of the Companies Acts.

The little book now referred to, which is fully indexed, contains many further particulars (including the details to be registered) that are necessary to be known by those to whom the Act may apply; and all cases of exceptions to the various requirements are carefully set forth. It is time now to consider registration, which, in the cases of businesses carried on before Dec. 22 last or commenced within two months thereafter, must be effected between Feb. 21 and March 22.

Prohibition of the Export of Sulphate of Ammonia.

We have now before us a full report of the speech recently delivered by the Right Hon. R. E. Prothero, M.P., President of the Board of Agriculture, at Bedford. In the course of it, he distinctly states that the export of sulphate of ammonia has been prohibited, and licences withdrawn, except as to a limited quantity. He said: "Then, take fertilizers. There are three fertilizers, or two fertilizers and one other material, which are home produced. They are sulphate of ammonia, basic slag, and for the other material, sulphate of copper. Sulphate of ammonia is one of our few home-produced manures. We have prohibited its export, and we have withdrawn the licences for its export, except as to a limited quantity for our Overseas Dominions. Remember, they are growing food for us. We hope that there will be enough sulphate of ammonia to go round. But the war requirements are very large; and we shall have perhaps to be very economical in its use. At all events, we have got the matter in hand; and you may rely upon it that, if we can, we shall provide for all the requirements of sulphate of ammonia."

Benzol for Motors.

Many of the more important gas and colliery undertakings which have installed benzol recovery plant for meeting the urgent demands for war purposes have, says "Engineering," been approached by representatives of the motor industry as to their probable future production of benzol. Benzol is recoverable to the extent of about 1 to 1¾ gallons per ton of coal carbonized in the process of coal-gas manufacture; and future supplies may largely depend upon a sufficient outlet for the resultant coke being obtained. In the past, surplus coke has been used in the manufacture of carburetted water gas, which contains little or no benzol, and is dependent upon imported solar oil—now much enhanced in price, owing to shortage of tank tonnage. It will, therefore, be seen that while it is to the national advantage, and also to the interest of both the gas and the motor industries, to minimize, so far as possible, the use of imported fuels, it is incumbent upon the motor interest, which desires to see abundant supplies of benzol, to assist by making the fullest possible use of the residual fuel, gas coke.

Calorific Standard Applications and Orders.—The Board of Trade have received applications for the fixing of a calorific standard of 500 B.Th.U. from the Sutton Gas Company and the Worthing Gas Light and Coke Company. The following further Orders have been made by the Board: Bridlington Gas Company, Stirling Gas Light Co., Torquay Gas Company, Weston-super-Mare Gas Light Company.

Calorific Tests in Canada.—With regard to the calorific standard now in force in Canada, it is stated that in only 24 tests made by the Inland Revenue Department of the Dominion during the year ended March 31, 1916, was the gas supplied by the Canadian gas companies found below the 520 B.Th.U. standard established as a minimum for calorific tests. In all, 2249 tests were made; the majority being much above the required figure. The yearly average of the Charlottetown Light and Power Company, of 710 B.Th.U., was the highest yearly average maintained. This plant manufactures coal gas,

OCCURRENCES IN THE COKE-OVEN DURING CARBONIZATION.

Before the Western Section of the Coke-Oven Managers' Association, at their December meeting, Mr. D. V. HOLLINGWORTH, F.C.S., of Lawton (the Hon. Secretary), read a paper dealing with the subject of the "Occurrences in the Oven during the Carbonization of Coal," which led to a good discussion at a further meeting of the section on the 6th inst.

In the first place, the author offered some remarks on the nature and composition of coal—referring to the investigations of Lomax, Aitkin, Bedson, and Wheeler. It would, he said, seem that there is a definite connection between the results of these experimenters, which together establish the opinion that coal is composed of at least two definite types of substances—one of a resinous nature, which easily breaks up at low temperatures, and yields principally paraffins, and which under ordinary conditions of burning yields smoke; and one which requires a higher temperature to break it up, and which yields principally hydrogen. Further, it has been established that it is the resinous portion of coal which produces its caking or fusing properties, because on carbonization it first breaks-up to a pitchy residue, which causes the particles of true coke to become agglomerated together. This resinous matter is easily oxidized by exposure to air, and when oxidized the coal will no longer produce an adhesive coke.

Having thus briefly indicated the composition and constitution of coal, some consideration was given to the effect of heat upon it. Upon this point, Mr. Hollingworth said it is generally agreed that the whole effect of Nature's processes upon vegetation is one of destruction and simplification; the complex substances comprised under the term vegetation being broken-down by various agencies into carbon dioxide, water, and nitrogen. The formation of coal itself marks a stage in this process towards simplification, as though by comparison with such substances as carbon dioxide it appears very complex, yet by comparison with the vegetation from which it is derived, it is really a simple substance, containing carbon in very much larger proportion. There is therefore some analogy between the slow carbonization of Nature and the rapid artificial carbonization which goes on in coke-ovens, as it would appear that the principal result of heating coal, in the absence of air, is also to produce substances of simple nature. Without doubt, the reactions occurring in the oven during the carbonization of coal are all in accordance with well-known laws; and it should be the duty of those in charge of such processes to learn what these rules are. Just at the time when the heat of the oven breaks-down the stability of the coal, several important forces help in determining the character and amount of the various products formed; and the essence of good management of a carbonizing plant consists in controlling these forces so as to achieve the end in view.

Seven of these factors were enumerated by the author, who then proceeded to examine their action. The first two were the composition of the coal and the amount of moisture it contains. He pointed out that on the days when the moisture is abnormally high, the yield of all products will suffer; but when both ash and moisture are high, it is a really bad look-out for the products. The composition of the ash of coal has an important bearing on the products obtained. Any coal containing much iron will give far less ammonia than one free from iron; while a coal containing lime will give more ammonia than one free from it. All iron pyrites should be scrupulously removed from coal.

Another factor is the intensity of the heating. There can be no doubt that the nature of the substance produced is very dependent upon the degree of temperature. Broadly speaking, at low temperatures there are produced much soft, easily ignitable coke, containing perhaps 10 p.ct. of volatile matter; little gas, containing little ammonia; some pyridine; much tar of a paraffin nature, and containing little benzol; and no naphthalene. Here is a heavy gas, very rich in illuminating hydrocarbons (olefines). At a moderate temperature, there are obtained less coke, of a hard, tough nature containing about 3 p.ct. of volatile matter; more gas of poorer quality, containing much ammonia; less tar, but more benzol, naphthalene, and pyridine. At a very high temperature, there results still less coke, of hard, brittle nature, and much fissured, containing less than 1 p.ct. of volatile matter; still more gas; little ammonia, but much free nitrogen and cyanogen; less tar, of a thicker quality, more free carbon in it, and high homologues and pitch. As bearing on the question of temperature, Mr. Hollingworth quoted the following results showing the yield of various products obtained by carbonizing the same coal at widely different temperature. The figures are per ton of air-dry coal. Carbonized at about 600° C.: Soft, easily ignitable fuel, containing 10 p.ct. of volatile matter, 14¾ cwt.; thin, oily tar, 17 gallons; ammonia as sulphate of ammonia, 15·2 lbs.; spirit extracted from gas, 2·8 gallons; spare gas, *nil*. Carbonized at about 1000° C.: Hard coke, containing 2 p.ct. of volatile matter, 13¼ cwt.; tar, 9¼ gallons; ammonia as sulphate of ammonia, 34 lbs.; crude 65 p.ct. benzol, 3·3 gallons; spare gas, 5000 c.ft.

The paper contained a table showing the influence of temperature on tar; the remark being made that it would seem the results indicated were brought about, not merely by the intensity of the heating, but by the length of time the first-formed substances are in contact with the heat, and by the degree of protection afforded to the valuable gases by other inert gases or steam. No matter what quantity of valuable products are yielded at any given temperatures, much of them will be rapidly destroyed if they are not quickly drawn away from the influence of the heat. It is therefore highly important that the products should not be hindered in their passage towards the outlet from the oven, but should be taken away as soon as possible. It is in this connection that the moisture in coal plays such an important part in modifying the reactions occurring in the oven and preventing the destruction of the gases that are first formed. The moisture, as steam, envelops the ammonia and other products, and protects them from the radiant heat of the oven walls and crown, and the conducted heat of the incandescent coke. In the absence of this protective action, it has been repeatedly demonstrated that with high temperatures much of the ammonia is decomposed by the incandescent carbon to cyanogen, and with very high temperatures to free nitrogen, which is found in the gas, and is of no value to anyone.

For confirmation of the practical value of steam in protecting ammonia from destruction, continued Mr. Hollingworth, one has only to compare the yields in gas-works, where dry coal is used (20 to 25 lbs. of sulphate of ammonia per ton), with those on coking plants, where, under the prevailing conditions of from 8 to 10 p.ct. of moisture in the coal, the yields are from 30 to 35 lbs. of sulphate of ammonia, and also with those on Mond producers, where, with the use of steam-saturated air, yields of 80 lbs. of sulphate of ammonia are obtained. As affording a striking illustration of the influence of temperature on the yield of ammonia, figures were quoted relating to the heating of the same weight of coal for the same time at different temperatures. At 600° C., the nitrogen as ammonia was 10·6 p.ct.; at 700°, 19·6 p.ct.; at 800°, 21·7 p.ct.; and at 900°, 20·8 p.ct. Granting that all the reactions and their causes were as he had stated, he said it might be asked, "How can we operate our ovens so as to obtain the maximum yield of all products?" This was the point upon which he hoped to hear the opinions of members.

Expressing his own ideas on the subject, he said that, bearing in mind the fact of the resinous portion of coal being easily oxidized by exposure to air, and that such oxidized coal will no longer possess coking properties, it is clear that coal should be used in as fresh a condition as possible. Wet slack such as is employed in the case of most coke-ovens is specially prone to alteration in coking property through such oxidation. Unfortunately, the construction of the slack storage bunkers is not always of a character to permit of the use of only freshly-won coal for coke making. Often the bunker is so arranged as to form pockets, wherein large quantities of slack remain undisturbed for indefinite periods, though there may be a continuous passing of slack in and out of the bunker. With respect to the composition of the slack, the minimum percentage of sulphur should be ensured by careful elimination of pyrites and shale on the picking-band, and by scientific control of the slack washing. The moisture permitted to remain in the slack should be as near 9 p.ct. as possible. This has been determined as the ideal figure, having regard to the questions of heat loss, bulk and strength of liquor, &c. It would be better if the moisture were 2 p.ct. above this figure, rather than 2 p.ct. below it.

With reference to the intensity of the heating, this, Mr. Hollingworth proceeded, is controllable, and ought to be controlled. As far as possible, the ovens should be raised or lowered in temperature *en masse*, and not individually. It is bad practice to be continually adjusting the gas-cocks. Whenever practicable, the heating-gas pressure should be raised or lowered instead. Tampering with the heats as between one shift and another should not be permitted. The damper should not be altered by anyone except the manager; and the two extremes of damper position should be avoided. The lowest damper consistent with having a clear atmosphere in the flues should be aimed at. A sufficiently well-spread-out flame should be worked with, to prevent local heating of the ovens. The ovens should be well filled with level charges; and they should be discharged in regular order.

The speed of removal of the products from the oven, the author considers one of the most important points in management. This, he suggested, ought to be perfectly under control, by: (1) Ensuring a regular and proper cooling of the gases, whereby the exhausters have an even bulk of gas to deal with. (2) By keeping thoroughly clean the ascension-pipes and mains, and specially the valves. The latter is ensured by the use of a chart indicating when valves were last dismantled and cleaned. (3) By the use of properly-acting main governors. (4) By proper levelling of the slack to prevent back-pressure. (5) By keeping such a vacuum in the mains as will leave just the slightest pressure on the oven when at its maximum output.

The final paragraph of the paper consisted of an allusion to the extreme value of some means of measuring the gas made. It was pointed out that a meter properly installed provided the most valuable means that one can have of controlling the working of the ovens. With such an instrument—particularly if

used in conjunction with a recording calorimeter—the manager is informed at once of any departure from normal working, and can act accordingly.

DISCUSSION.

In the course of the subsequent discussion, the Chairman (Mr. W. Surtees) said he thought it had been established that most recently formed coals have been found to decompose at a lower temperature, and to give a larger proportion of nitrogen as ammonia, than coals of a greater age. The presence of lime in the ash should have a beneficial action in increasing the ammonia yield. Alluding to the disparity between the yields of ammonia at gas-works and coke-oven and producer-gas plants, he suggested that the lower yield at gas-works is due to charges not being so thoroughly burned-off as they are in coke-oven practice. It seemed to him that the comparatively large yields of ammonia in producer plants is not altogether due to the beneficial action of the steam in preserving the ammonia, but that the carbon dioxide and hydrogen also are similarly effective. As to the effect of stamped or unstamped charges on ammonia yields, after having had considerable experience of both, his opinion is that the latter give the better results.

In a written communication, Mr. E. M. Myers remarked that there is no doubt the root principle of all their bye-products lies in the act of carbonizing; and it is therefore highly important to endeavour to learn how to obtain results which can more or less be under control by simply manipulating the method of carbonizing. Such points as suction, back-pressure, and moisture, ash, and iron content of the slack used, heavy or light charges, compressed or uncompressed, and, last but not least, the temperature of the walls, should be so understood that, by the alteration of one or more of these factors, certain designed results will be effected. Herein, he added, lies a vast field for research which it should be the object of the Association to foster. He hardly agreed with the author that the effect of moisture during carbonization is for the water to be volatilized and form a protective covering to the ammonia. Is it not, he asked, a fact that a definite chemical change takes place when steam is passed through a glowing mass of nitrogenous organic matter? He would be interested to learn of any theories as to the reasons governing the formation of ammonium chloride in varying quantities from the same coal.

According to Mr. J. E. Christopher, his own experience amply bears out the statement that two coals showing the same ultimate analysis would give widely differing results. He emphasized the author's remarks concerning the removal of iron pyrites, as much because of the action of the iron in reducing ammonia yields, as because of its destructive action on the brickwork. Inasmuch as sulphur is so objectionable a constituent of coke, and comes largely from the pyrites left in the slack, he thought every endeavour ought to be made to remove this impurity from coal.

In his remarks, Mr. J. Escott Wood dealt mainly with nitrogen and ammonia, as, generally speaking, the conditions favourable to good yields of ammonia are also favourable to the production of other bye-products. Coke, however, is the primary object of their operations; and the conditions in the ovens for producing a large output of coke rapidly are by no means identical with those for getting good yields of ammonia. The moisture-content referred to by the author has at least three effects in the ovens assisting to good yields of ammonia: Cooling the brickwork; protecting the ammonia evolved, by dilution; and liberating the nitrogen as ammonia. As to the last-named, it is well known that the nitrogen in the coke can be transformed in a large degree into ammonia by passing steam through the heated mass; and this partly accounts for the high yields of ammonia in bye-product producer practice. In his opinion, coke-oven managers are not so much limited to a given figure in moisture-content by deleterious effects on the bye-product yields, as by the practical difficulties of dealing with wet slack. Where blast-furnaces are adjacent to the coke-ovens, a promising method of improving the yields has been suggested; it having now been demonstrated under actual working conditions that blast-furnace gas can be used as a diluent and cooling agent with good results. Figures published by Dr. Zimmermann show an increase of 15·2 p.ct. in ammonia yield. As to other points, it is essential that coke-ovens be as well filled as possible, and, to ensure regular working, with the same weight of fuel, having practically the same moisture-content. Compressing the charge has in many instances increased the yield of bye-products.

In his reply, Mr. Hollingworth suggested that compression *per se* has little influence either way on the ammonia yield; but uncompressed charges, being lighter, require usually a somewhat lower temperature than the heavier compressed charges, which may account for different results under varying circumstances. With regard to the effect of moisture during carbonization, all gases would exert a protective effect on ammonia, if only by dilution; but there is no doubt that the part played by steam, or its constituents, is by far the most important. It is not certain that the steam generated in the cooler part of the charge does pass through the incandescent carbon. In fact, present opinion rather tends the other way. Whatever ammonia did pass through that portion of the charge already carbonized, adjacent to the walls, and between the walls and the charge, would have little chance of surviving, were it not for the steam and other gases accompanying it. In view of all the facts, he thought he was quite correct in saying that the action of steam in increasing the yields of ammonia is due to its protecting influence rather than to the fact that it provides the necessary hydrogen. What he meant when referring to high moisture-content was, of course, that with an exceptionally large amount of moisture present there would be so much less coal. The working out of ideas resulting from laboratory research is always hindered by the difficulty experienced in carrying out any modification of plant or process, while at the same time preserving a full output. He suggested that this difficulty could best be solved by the Government providing a fund amply sufficient to instal experimental plant on a full working scale, and by closer co-operation between the industries concerned, and between them and the universities, whereby a fuller interchange of ideas would be rendered possible.

THERMAL DECOMPOSITION OF LOW-TEMPERATURE COAL TAR.

By D. TREVOR JONES, M.Sc., of Saltcoats.

[A Paper read before the Glasgow Section of the Society of Chemical Industry.]

The mechanism of the process by which coal tar is formed in the gas-retort has been the subject of much speculation and controversy. The various theories which have been propounded regarding this process resolve themselves into two classes: (1) Those which assume that the components of coal tar are formed by the combination of various small molecules—such as acetylene—which are regarded as primary products of the destructive distillation; and (2) those which assume that the coal substance is itself essentially aromatic, and that the benzene and other aromatic distillates are themselves primary products of the breakdown of coal. This second theory has been put forward by Heusler as the result of observations made on bituminous coals, brown coals, and lignite.

The theory that coal is a mixture of aromatic substances can only be upheld if observations are confined to its distillation products obtained at temperatures of 700° C. and upwards. Coal is certainly not aromatic in the structure of any of its chief components, though it must be admitted that but little is as yet known of its chemical nature. It is formed from decayed vegetable matter, which has been subjected to very considerable pressure, and in many cases to such a degree of heat as would suffice to bring it to the stage of incipient distillation—*i.e.*, between 250° and 300° C. This was argued on purely chemical grounds by Jones and Wheeler, who pointed out that certain English bituminous coals yielded on extraction with solvents the identical paraffin $C_{27}H_{56}$, which they yielded in much larger quantity on distillation. They pointed out that a similar conclusion could be drawn from the earlier results of Pictet and Ramseyer, who extracted from a Montrambert coal the readily polymerizable hexahydrofluorene, along with traces of bases and phenols—these two last being primary products of low-temperature distillation. More recently Pictet, Ramseyer, and Kaiser have extracted from 5 tons of coal, 0·25 p.ct. of tar which is closely identical in many of its components with that obtained in quantity from the same coal on distillation at 450° C.

Coal is, therefore, to be regarded as a mixture of substances of vegetable origin, which have undergone change as the result of bacterial decay, pressure, and heat. The original main components, the cellulose and the sap, have both suffered change as the result of the action of these agencies but not to such an extent as to render impossible their identification and separation. Preliminary loosening of the coal substance with pyridine, and a final extraction with chloroform has led to the separation of these two portions; the degraded cellulose being the insoluble component, the sap the soluble one. Separate destructive distillation of these shows that the cellulose portion yields phenols, while the sap yields what is virtually petroleum. These combined distillates, as obtained from the unresolved coal by distillation *in vacuo* below 450° C., constituted a tar of low specific gravity (·967 to ·999$^{15}/_{15}$). This tar was 6½ p.ct. of the weight of the coal. The portion of it, about one-half, which distilled below 300° C. at ordinary pressure contained: (1) Unsaturated hydrocarbons (40 to 45 p.ct.); (2) naphthenes; (3) liquid paraffins—the two last-named being about 40 p.ct. of the oil, with the naphthenes preponderating; (4) phenols, chiefly cresols and xylenols (12 to 15 p.ct.); (5) aromatic compounds, which, on account of the stability of their picrates to water,

were considered to be homologues of naphthalene; (6) pyridine bases, in traces; (7) traces of a solid paraffin, $C_{27}H_{56}$. Benzene and its homologues were absent, as were also naphthalene, anthracene, phenanthrene, and solid aromatic bodies generally. The aqueous distillate was strongly acid, and was found to contain hydrochloric acid, with which traces of ammonia were combined.

It seemed a matter of interest to investigate the thermal decomposition of this tar; and, with Dr. Wheeler's concurrence, the author undertook this investigation independently. The first experiment carried out was the decomposition of the tar at 650° C., with the object of obtaining the liquid products of decomposition. The tar taken had a specific gravity ·967 $^{15}/_{15}$ and contained carbon 86·32 p.ct., hydrogen 9·53 p.ct. (C+H= 95·85). It was allowed to flow over coke packed in a vertical tube of hard glass, which was heated in an electric furnace. The temperature was registered by means of a platinum-platinum-rhodium thermocouple, the junction of which was inserted in the hottest part of the furnace. The length of the heated zone was 30 cm.; and the gas capacity of the heated zone of the decompostion tube was 30 c.c. The temperature of decomposition (650° C.) was kept fairly constant, within about 6° C. The liquid was run in at the rate of about 5 c.c. per hour. Gas was formed to the extent of 220 c.c. per gram of tar taken. The first receiver, which was air-cooled, was fitted vertically below the decomposition tube, so that the heavier liquid products of decomposition ran directly into it. The second receiver was cooled in a mixture of solid carbon dioxide and ether contained in a Dewar vessel. The permanent gases were allowed to escape. The tar collected in the first receiver was 55 p.ct. of the weight of the original tar. It had a specific gravity = 1·043 $^{15}/_{15}$, carbon 88·51, hydrogen 7·18 p.ct. It contained a little water in suspension. It began to boil at 128° C., and distilled 19 p.ct. at 200°, 37 p.ct. at 250°, and 50 p.ct. at 300° C.

The distillate coming over below 300° C. was washed with caustic soda to remove phenols, and with dilute sulphuric acid to remove bases. The separate fractions had the following characteristics:

—	Fraction I.	Fraction II.	Fraction III.
Range of boiling point	110° to 180°	180° to 260°	260° to 300°
Specific gravity	·8645	·9093	1·000
Carbon	90·55	90·63	91·36
Hydrogen	9·04	9·11	7·52
C + H	99·59	99·74	98·88

If these figures be contrasted, so far as is possible, with those given by the original tar oils, the increase in specific gravities and carbon content are at once apparent, even when the fractions from the new tar are of lower boiling range than those from the original.

Low-Temperature Tar Oils.

—	Fraction I.	Fraction II.	Fraction III.	Fraction IV.
Boiling range	160° to 200°	203° to 250°	250° to 275°	275° to 300°
Specific gravity	·8045	·8556	·8903	·9278
Carbon	86·28	87·88	88·13	88·24
Hydrogen	13·11	11·65	11·09	10·36
C + H	99·39	99·53	99·22	98·60

From the observation that oxygen is absent from the neutral oil fractions obtained after decomposition, it follows that cumarone, C_8H_6O, and its homologues are also absent. As their absence from low-temperature tar has been similarly demonstrated, it must be presumed that this substance is formed at higher temperatures, either synthetically or by direct distillation from the coal.

The increases in specific gravity and in carbon content, alluded to above, are due to two causes—increased aromatic formation and increased olefinic linkage. The latter was the predominant factor, though it was difficult to distinguish accurately and quantitatively between the two; the difficulty being accentuated by the smallness of the amounts available for examination. A further difficulty was occasioned by the fact that aromatic substances were present in the original tar; and these passed through the heated zone apparently unchanged. A small quantity of aromatic substances of specific gravity ·89 (determined by flotation) was distilled from a strong sulphuric acid wash of the lower fractions, and the aromatic substances originally present were recovered from the higher boiling portions. No solid aromatic substances, such as naphthalene or anthracene, could be detected in the tar.

A study of the gases formed at various temperatures was therefore begun. The only aromatic substance which could possibly affect the gas analyses in any way was benzene, and that only to a limited extent, owing to its low vapour tension, and to its comparative absence at the lower temperatures of decomposition. The gas absorbents used were: (1) Sulphuric acid of 96 p.ct. strength. This removes olefines containing from three to six carbon atoms in the molecule—thus discriminating between ethylene and the higher members of the series. (2) Ammoniacal silver chloride for acetylene. (3) Bromine in potassium bromide solution for ethylene. (4) Freshly-prepared ammoniacal cuprous chloride for carbon monoxide. Hydrogen was estimated by removing it with "burnt" palladium at 96° C., and the remaining methane and ethane were determined by explosion.

Investigation was first made of the gases which were boiled-off at a temperature range of −80° C. to +35° C. from the either CO_2 cooled receiver, which served as the second condenser in the experiment carried out at 650° C., as described above. The gases so obtained were found to contain paraffins 21·1 p.ct. (C_2H_6 11·88 p.ct., C_3H_8 10·3 p.ct.), ethylene 5·3 p.ct., higher olefines 72·6 p.ct. [Gases absorbed by strong sulphuric acid, consisting of olefines containing more than two carbon atoms, are described throughout this paper as being "higher olefines."]

The marked preponderance of the olefines over the saturated hydrocarbons is very noticeable, and is in striking contrast to the corresponding gas fraction obtained direct from coal at 450°, which was found to contain total olefines 23·5 p.ct., and paraffins 75·4 p.ct. The higher percentage of olefines at this stage was also observed in the liquid fraction from which they had been distilled (boiling point 35° to 120° C.), which appeared to contain over 60 p.ct. of olefinic substances.

It was then decided to decompose small quantities of the tar at successive temperature increments of 50° C.—beginning at 550° C., the lowest temperature at which such decomposition was rapid enough to be conveniently studied under the same conditions as held at higher temperatures. The method adopted was the simple one of distilling a small quantity of the substance over heated porous porcelain in an atmosphere of carbon dioxide, and finally sweeping out the gaseous products of decomposition with carbon dioxide and collecting them over potash in a nitrometer. About 0·1 gram. of the substance was placed in a small porcelain boat, which was inserted in the back end of the hard glass decomposition tube (a quartz tube was used at 800°), heated in an electric furnace 30 cm. long and fixed horizontally. Any backward diffusion of the vapours was prevented as far as possible by the insertion of a plug of glass-wool at the back of the boat. After the boat had been placed in position and all air driven out by carbon dioxide, the current of the latter was shut off, and the nitrometer filled with potash. The tube was then moved along so as to bring the boat into the hot zone of the furnace. The tar was then distilled and decomposed. The results obtained in the form of percentages calculated as "nitrogen-free" are set forth in the following table:

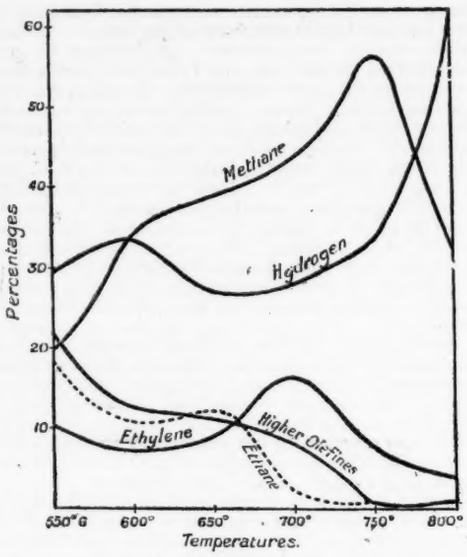
Temp.	Higher Olefines.	C_2H_2.	C_2H_4.	H_2.	CH_4.	C_2H_6.
(2) 550° C.	21·7	0·7	10 4	29·4	19·6	18·2
(3) 600° C.	12·5	1·3	7·4	33·6	33·9	11·3
(4) 650° C.	11·4	0·9	9·3	27·4	39·0	12·0
(5) 700° C.	8·2	1·3	16·1	28·2	43·8	2·4
(6) 750° C.	0·7	1·2	7·6	33·2	56·1	1·2
(7) 800° C.	1·0	1·3	4·0	60·7	33·0	..

As carbon monoxide is formed as the result of the action of nascent hydrogen on carbon dioxide at the given temperatures, no column is assigned to it in the table; and it is calculated in the hydrogen. A separate experiment showed that when the tar was decomposed *in vacuo* at 550° C., only 0·6 p.ct. of carbon monoxide was found in the resulting gas. Carbon monoxide is found in quantity in coal gas, but it proceeds largely from the insoluble portion of the coal, and to a much less extent from the soluble portion from which the bulk of the tar is derived. The figures given represent the percentages of the various components in the gas mixture and not the absolute amounts.

No examination was made of the liquids. It was observed, however, that naphthalene was deposited in the front end of the tube at 750° C., though not below this temperature. It will be noticed from the diagram [p. 200] that ethylene increases to a maximum at 700° C., and then falls; acetylene is uniformly low and almost negligible; the higher olefines fall from a maximum of 250° almost to zero at 750° C.; hydrogen averages about 30 p.ct. till 750° C. is passed, when the curve becomes steep; methane rises rapidly to 750° and then falls.

In order to avoid confusion with the curves for ethylene and the higher olefines, the curve for ethane is indicated by a dotted line. It shows a fairly steady decline.

No simple explanation is vouchsafed for the contour of the ethylene curve. The rise may perhaps be explained in part by the fall in the ethane, and also by the direct formation of ethylene as a primary decomposition product of the various tar components, saturated and unsaturated. Analyses (8), (9), and (10) show that from 20 to 30 p.ct. of ethylene was present in the gases obtained by rapidly decomposing various oil fractions at 650° C. The low percentages of acetylene call for remark, in view of the important rôle which has been assigned to this compound as a participant in coal tar formation. If, as is still held by some, acetylene plays a prominent part in coal tar formation, it should be present in much larger quantities than are here indicated. Bone and Coward have



shown that the velocity of polymerization of this gas when formed by the thermal decomposition of ethylene at 570° to 580° is not so rapid as not to allow of its accumulation to the extent of from 6 to 7 p.ct., at which value it remained fairly constant after prolonged heating.

The curve for the higher olefines differs considerably from that of ethylene in that it exhibits a steady decline from 550° to 750° C. The higher olefines practically vanish at this latter temperature; and their disappearance synchronizes with the appearance of naphthalene, and with the commencement of a marked increase in the hydrogen. This fall in the curve finds a counterpart in the results of Egloff and Twomey obtained by them when decomposing Pennsylvanian petroleum. They observed, particularly in the case of the low boiling fractions, that the liquid olefines were at a maximum at 550° C., and that there was a more or less steady fall in the curve from 44 p.ct. at that temperature to 5 p.ct. at 800° C. Their curve does not, however, coincide with the gas curve given, in that it shows there is still 25 p.ct. of liquid olefines remaining at 700° C. and 15 p.ct. at 750° C.

Ordinary coal tar oils—particularly the lower fractions—contain very little olefines. In ordinary crude benzol from coal tar, the olefines present, which are removed as "acid tar" with strong sulphuric acid, amount to about from 2 p.ct. to 4 p.ct. of the whole. A fraction of similar range of boiling point obtained from low-temperature tar lost over 50 p.ct. of its volume as "acid tar" on washing with strong sulphuric acid.

The higher olefine curves differ from those of Zanetti, who observed that a propane-butane mixture yielded a maximum of "unsaturateds" at 750° C. Zanetti, however, makes no distinction between ethylene and other olefines; and the high percentage of "unsaturateds" probably consists very largely of the former. It is to be observed that Zanetti comments on a rapid increase in hydrogen and aromatic substances immediately above 750° C.

Staudinger's work on di-olefines with conjugated double linkings appears to have a distinct bearing on the results already recorded. It was observed that di-olefines of this type yielded aromatic substances in quantity when heated to 800° C. Isoprene first gave aromatic substances in quantity at 750° C., along with unsaturated substances. At 800° C. the aromatic substances had increased, while unsaturated had almost disappeared.

Staudinger further identified butadiene, the simplest di-olefine of this type, in gas distilled from coal *in vacuo*. Its formation from naphthenes has been demonstrated, as it has also from many olefines and saturated hydrocarbons. It also appears prominently in various petroleum vapours as the result of decomposition at 700° C.

These combined results tend to show that in coal tar formation the bulk of high-temperature tar is formed by the decomposition of the low-temperature tar into olefines, and the condensation of these at 700° C. and upwards to aromatic substances. It is highly probable that a necessary transition stage is the formation and condensation of olefines containing the stable conjugated double linkage—CH : CH.CH : CH. Polynuclear aromatic substances are formed at 750° C. and upwards subsequent to the disappearance of the olefines. With certain reservations which are discussed below, the process is represented by the simple scheme:

Low temperature tar → Higher olefines → High temperature tar (liquid and gaseous).

The mechanism of the condensation has not yet been investigated. The suggestion that naphthenes are intermediate products in the condensation cannot be upheld in view of the observation made by the author that these substances break-down at 500° C.

The formation of gaseous olefines is more marked in the case of certain tar-oil fractions than of the tar itself, as can be seen from the table at foot of page, which gives results obtained in 650° C

Certain modifications relating to the phenols, benzenoid substances, and pitch must be made in the above scheme. The phenols of high-temperature tar must be regarded as having been formed with certain changes from the phenols of low-temperature tar. Much of the high-temperature pitch is formed by partial carbonization of the low-temperature pitch.

Benzenoid substances besides being formed synthetically from olefines, are formed to a limited extent by the elimination of six hydrogen atoms from the corresponding naphthenes. This change, however, only takes place to a very limited extent. Naphthenes of the cyclohexane series do not break-down entirely in this way, but also undergo scission of the ring, with formation of olefines, including butadiene and paraffins. The author has shown that both these processes of break-down take place at 550° C. This is also manifest in analysis (9), where the fraction concerned consisted largely of naphthenes. If all the benzene, toluene, and their homologues found in ordinary coal tar were obtained directly from naphthenes by simple elimination of hydrogen, it follows that, at temperatures not much above 550° C., coal would yield the maximum possible amounts of these substances. It is well known, however, that when coal is distilled at dull redness only small quantities of benzenoid hydrocarbons are found in the tar.

It might be argued that the naphthalene deposited at 750° C. may have been derived from the methylnaphthalenes originally present by a form of decomposition analogous to that by which xylene successively yields toluene and benzene. The presence of naphthalene cannot, however, be adequately accounted for in this way. A tar-oil fraction from which methylnaphthalenes had been removed with picric acid was thermally decomposed at 750° C.; and it was observed that naphthalene was deposited in quantity at the front of the tube. The gas analysis (11), it is to be observed, shows very little higher olefines.

—	Higher Olefines.	C_2H_4.	H_2.	CH_4.
(11) . . .	1·9	10 9	18·3	68·9

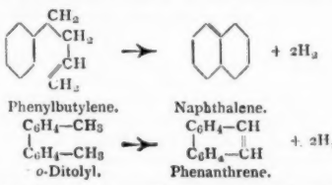
An explanation of the formation of hydrogen at intermediate temperatures has been given above in discussing the thermal decomposition of the naphthenes. Some hydrogen may also have been formed to a less extent from other hydrocarbons, notably ethane. Its increased formation at temperatures over 750° with the concomitant appearance of polynuclear aromatic substances has not been explained. Similar observations as to increased hydrogen formation have been recorded by Zanetti with a propane-butane mixture, and by Burgess and Wheeler with bituminous coal and with anthracite. In all three cases it was observed that the hydrogen curve became steep above 750° C.; and Zanetti also noticed increased aromatic formation at the same temperature.

As very few measurements have been recorded of the conditions of thermal decomposition of individual substances at these temperatures, it is not at all an easy matter to explain the above coincidences. Smith and Lewcock have observed that the combination of two molecules of benzene to diphenyl with elimination of hydrogen takes place slowly at 655° C., and rapidly at 720° C. With increased concentration of benzenoid substances some combination of this kind must inevitably occur. Diphenyl is known to be a constituent of coal tar. The observation of Burgess and Wheeler concerning anthracite shows that the increased formation of hydrogen is not dependent upon changes of such a kind as can only take place in the vapour phase. It could not for instance be asserted, if regard is to be had for these coincidences, that the increased hydrogen is due to the prior disappearance of olefines, which may hitherto have combined with and retained it. The change which produces this hydro-

Fraction.		Higher Olefines.	C_2H_4 (+ C_2H_2)	H_2.	CH_4.	C_2H_6.	Total "Unsaturated."
Sp. Gr.	Boiling Point.						
(8) 0·69	38—100° (olefine-free)	29·9	20·6	13·7	19·6	16·2	50·5
(9) 0·784	200—250° (olefine-free)	26·8	29·8	12·6	21·7	9·1	56 6
(10) 0·855	200—250°	24·2	22·6	21·6	25·5	6·1	46·8

gen is evidently of such a kind as takes place between large molecules and also intramolecularly. The increased production of hydrogen must probably therefore be attributed to the union of aromatic molecules, and to the intramolecular closing-up of side chains and rings of these to form new rings.

Some simple examples of these changes are the formation of diphenyl from benzene already mentioned, and that of naphthalene from phenylbutylene and of phenanthrene from stilbene and *o*-ditolyl:



The increased hydrogen formation in tar and petroleum fractions is thus necessarily concomitant with the formation of polynuclear aromatic substances; while the similar hydrogen formation in coal marks the beginning of the rapid conversion of the coal to polynuclear molecules of indefinite dimensions—a process which culminates in their coalescence to the aromatic molecule of carbon.

The curves for ethane and methane call for little comment. Bone and Coward have shown that the former decomposes rapidly at 675° C.; and that at 810° C. only 17·9 p.ct. remained after heating for one minute. The disappearance of ethane with rise of temperature was, therefore, to be anticipated. It is possible that paraffins higher in the series than ethane are present at lower temperatures. These would appear in the analyses as ethane; and the early rapid fall in the curve may be due in part to their decomposition.

Methane is a general product of most thermal decompositions, even of such substances as carbo-hydrates where its formation might be least expected. The observed rise in the methane curve is in accordance with this and with its known stability.

SUMMARY.

(1) Ordinary coal tar is formed from coal at high temperatures, chiefly as the result of the decomposition of a tar previously formed at low temperatures.

(2) The mechanism of this process consists essentially in the decomposition of the naphthenes, paraffins, and unsaturated hydrocarbons present in the low-temperature tar to form olefines of varying carbon content which condense at higher temperatures to aromatic substances.

(3) The higher (gaseous) olefines are at a maximum at 550° C.—the curve descending to a minimum at 750° C., when they virtually disappear. Their disappearance at 750° C. synchronizes with the appearance of naphthalene, and immediately precedes a rapid increase in the evolution of hydrogen.

(4) Hydrogen is formed at middle temperatures chiefly as the result of the decomposition of naphthenes. The increase at higher temperatures must probably be attributed to the union of aromatic molecules and to intramolecular ring-closing.

(5) Phenols are primary products of coal distillation.

(6) Benzene and its homologues chiefly result from olefinic condensation. To some extent they are secondary products of coal distillation, having been formed by the thermal dehydrogenation of the corresponding naphthenes.

(7) Acetylene plays an insignificant part in coal-tar formation.

Rectification of Benzol.

At a meeting at Leeds, last Thursday, of the Midland Institute of Mining, Civil, and Mechanical Engineers, a paper on "The Rectification of Benzol," was read by Mr. Walter N. Drew, of Thorncliffe, Sheffield, who observed that every gallon of benzol and toluol (which were explosive bases) were needed for the Allied cause. What would happen after the war? A certain amount of these products would be required for dyes; but probably 40,000 gallons per annum would have to be sold as motor spirit. This benzol must be of standard quality, as regards the distillation test, purity, and dryness. It must be obtainable everywhere in standard 2-gallon tins at a standard price. What had been done, he asked, to prepare for this market by the producers as a body? Nothing whatever. As far as he knew, if the war were to stop to-morrow the industry (including the gas companies) would have no organization whatever, and would be at the mercy of the highly organized petrol combinations, which had hitherto succeeded in selling an inferior fuel at a higher price.

The section of the annual review of "The Times Engineering Supplement" dealing with "Gas Engineering" commences thus: "To speak in a tone of some anxiety of so tractable an industry as that associated with gas engineering may sound anomalous to many of those who are given to looking upon this particular form of industrial activity as one which *generally manages to eke out a* moderately tranquil and profitable existence untouched by any of the perplexities resulting from a *general upheaval such as exists at present.*" It was not within our memory that the gas industry or any other industry had ever before experienced "the perplexities resulting from a general upheaval such as exists at present."

GAS FLOOD LIGHTING.

A full description, with photographs, of the effects produced in the exterior lighting of a compression house and station belonging to the Portland (Oregon) Gas Company has been published in the "Gas Record," from which the following details are abstracted. The term is applied to the brilliant and even illumination of the front of a building or other approximately flat area by means of high power lights fitted with reflectors that conceal the source of light on the side away from the building, and at the same time diffuse the light evenly over the desired area.

The face of the compression house is 42 ft. long by 20 ft. high. The lights are two in number, placed at an altitude of 12 ft. above ground level, and 15 ft. to the front; tests with reflectors having shown that the angle between a horizontal line through the source of light and the top line of the building should not

exceed 20°. The posts and heads are an elegant design, constructed in cement concrete, composed of one part of white Madusa cement and two parts of white shell beach sand, reinforced with a 2-in. iron pipe extending right through from the bottom foundation to the head, assisted by steel channel iron and stiff iron wire. The central pipe acts as a drain for the head and lower basin, and for the accommodation of a ¾-in. gas supply. After experiments with specially designed upright burners, a No. 50 Humphrey arc, with opal globe and clear shade, was selected in preference. The reflector on the inside of the post head, which also protected it from the heat of the lamp, was made of No. 26 gauge galvanized iron, enamelled with white "Vitriolite." The posts cost $100 each, the reflectors $14, the foundations and other incidental expenses $25; making a total cost of $139 per unit.

A Disclaimer.—We are asked to emphasize a statement made on another page of to-day's issue, to the effect that Messrs. C. H. Kempton & Co., of South Lambeth Road and Westminster Bridge Road, are not partners, and never have been partners, with W. J. Kempton, R. Kempton, and H. Kempton, referred to in the report in the "JOURNAL" last week, of certain proceedings at the Lambeth Police Court. The firm have no connection whatever with C. Kempton and Sons.

American Coke Production.—There was a record output of coke in the United States last year. More than 35,000,000 tons of beehive coke was manufactured, an increase of over 27 p.ct. compared with 1915. Bye-product coke amounted to 19,200,000 tons, an increase of more than 5,000,000 tons, or 36 p.ct., compared with 1915. The total coke production, according to estimates prepared by Mr. C. E. Lesher, of the United States Geological Survey, was 54,300,000 tons, an increase over 1915 of 12,700,000 tons, or 30 p.ct.

MEASUREMENT OF THE CALORIFIC POWER OF GAS.

DETAILS OF THE OFFICIAL METHOD USED BY THE PARIS MUNICIPALITY.

A full description of the apparatus, methods, and calculations adopted by the Services Generaux d'Eclairage of Paris for the calorimetric testing of town gas is the subject of an official booklet just issued. It is the work of M. L. Girard, the head of the laboratory concerned in the supervision of the lighting of Paris, and of M. P. Lauriol, the Chief Engineer. In publishing the following translation of it, we have retained the arrangement of numbered paragraphs of the French original, but as regards the diagrammatic plan of the apparatus have adopted a series of letter designations, a key to which is placed below the illustration, while one or two references are inserted in the text in passages where any possible confusion is thereby removed.

1. In first defining the principle of the method, the memorandum distinguishes between the gross and net calorific powers of gas as follows: Assume that the gas is consumed in a bunsen burner, and the products of combustion caused to traverse a metallic passage whereby they are cooled by water in circulation and brought to the surrounding temperature. Then, when equilibrium has been established, the heat evolved by the combustion may be said to be absorbed by the water and may be written:

$$C_1 = \frac{P\,(T_s - T_e)}{V}$$

where

C_1 (in calories per cubic metre) is the total heat produced by the combustion of the gas.

V (in cubic metres) is the total volume of gas burnt in the test.

P (in kilograms) is the quantity of water passing through the calorimeter in the course of the test.

T_e and T_s (in degrees C.) are the temperatures of the water at the inlet and outlet of the calorimeter.

The formula is the same if P is reckoned in grams and V in litres.

2. The net calorific power of the gas is defined in regard to the fact that the water vapour contained in the products of combustion condenses in the passages of the calorimeter, and yields up its latent heat, amounting, under the conditions of the test, to 0·592 calorie per gram. of condensed water.

Designating by p (in grams.) the quantity of water condensed during the passage of V_1 litres of gas, the quantity of heat produced by condensation of water-vapour, for every cubic metre of gas burnt is:

$$c = p \times 0{\cdot}592 \times \frac{1000}{V_1} = 592\,\frac{p}{V_1} \text{ calories per cubic metre.}$$

The net calorific power of the gas (in calories per cubic metre) is thus:

$$C = C_1 - c = \frac{P\,(T_s - T_e)}{V} - 592\,\frac{p}{V_1}$$

V and V_1 in the tests being respectively 12 litres and 120 litres, the formula becomes:

$$C = \frac{P\,(T_s - T_e)}{12} - 4{\cdot}94\,p.$$

3. This calorific power refers to a cubic metre of gas as measured by the wet meter employed—that is, to gas saturated with moisture, at temperature t_c (in degrees C.), and at the absolute pressure H (in mm. of mercury) prevailing in the meter.

In order to express the calorific power in reference to dry gas at 0° C., and at a pressure of 760 mm. of mercury, it is necessary to correct C by multiplying by the factor:

$$(1 + 0{\cdot}00367\,t_c)\,\frac{760}{H - F}$$

where F is the maximum vapour-tension of water (in mm. of mercury) at the temperature t_c.

4. A further correction requires to be applied for the error of the meter. The tests are carried out as though the meter was strictly accurate. The meter is afterwards subjected to check, as described in paragraphs 20 to 24, and its error obtained by noting the volume, $24 + e$ (in litres) read on its indicator for exactly 24 litres. The meter error is of the same form as that due to temperature. Calculations show that, with sufficiently near approximation and within limits foreseen as possible in the tests the required correction is obtained by substituting for t_c (*i.e.*, the temperature read at the meter) in the preceding formula, the temperature $t_c + 8{\cdot}5e$. It should be noted that e may have either a plus or a minus value.

5. The equipment for the test includes the calorimeter, precision thermometers, apparatus for the passage of gas and water, with other accessories.

The calorimeter employed is of the circulatory type, a standard instrument being lodged in the Municipal Lighting Laboratory. A vertical tubular body of metal is mounted on a tripod provided with levelling screws. The gas burns in the large central tube C from a burner constructed to consume about about 120 litres per hour at a pressure of 3 to 4 mm. of water. The products of combustion pass upwards in the larger tube, descend through a set of small tubes arranged round C, and pass off by a side outlet-tube, where readings of their temperature are taken by a thermometer t_g.

Water condensed from the products of combustion drips down the tubes and is collected in the vessel p.

The whole set of tubes is placed in a current of water, which enters the apparatus near the base by a tap fitted with a graduated scale, and passes out above through a two-way tap by which it can either be collected in the vessel or discarded.

The entire calorimeter is enclosed in a double nickelled and polished case—the space between the two surfaces forming an air-cushion. Also, all the surfaces of the calorimeter require to be kept in perfect condition. A thermometer, t_a, hung in the air about 2 in. from the calorimeter and separated from it by a screen, indicates the temperature of the surrounding air.

6. The thermometers T_e and T_s, recording the temperatures at the inlet and outlet of the calorimeter, are precision instruments, the readings of which are taken by the aid of a lens. Tables, kept in the testing room, give the corrections to be applied to the readings of each thermometer.

A rubber stopper, 1 to 1¼ in. high, serves to fix each thermometer to the calorimeter.

Improper fitting of a thermometer to the calorimeter may be the cause of an appreciable error. With the thermometers of the size used by the Municipal Service—one degree of which measures 7 mm. on the stem, and the distance from zero to the lower extremity of the reservoir being 90 mm.—the instrument is properly placed when the division − 3° appears above the top of the rubber stopper.

7. In the supply of gas to the calorimeter, there is first fitted beyond the main supply tap G1 a branch pipe carrying an open-flame burner consuming about 200 litres of gas per hour. This so-called "permanent burner" is placed outside the testing room, and is in action throughout the whole period of the tests. Its purpose is to increase the quantity of gas drawn from the main during a test.

The pressure of the gas in mm. of mercury is given by a manobarometer, G4, the cup of which is connected with the branch pipe at the inlet to the meter.

The (wet) meter takes 6 litres per turn of the drum. On the axis of the drum is fixed directly the pointer of the large dial. A thermometer t_c gives the temperature at the meter; while a tap allows of withdrawing the water.

After passing the meter, the gas traverses first a pressure regulator, G8, then a screw-down tap, G9, and then the burner of the calorimeter.

The pressure regulator or governor is set so that the pressure beyond is kept at 20 mm. of water. It is fitted with a levelling gauge (with register mark), a water-filled pressure gauge and fitment for blocking it.

When not in use, the burner is kept on the table outside the calorimeter. For a test, it is fitted in place by fixing its foot in the framework of the tripod which supports the calorimeter. A mirror, set at an angle, then permits of adjusting the flame, which should be blue throughout, and take a central position in the apparatus without touching the interior surfaces.

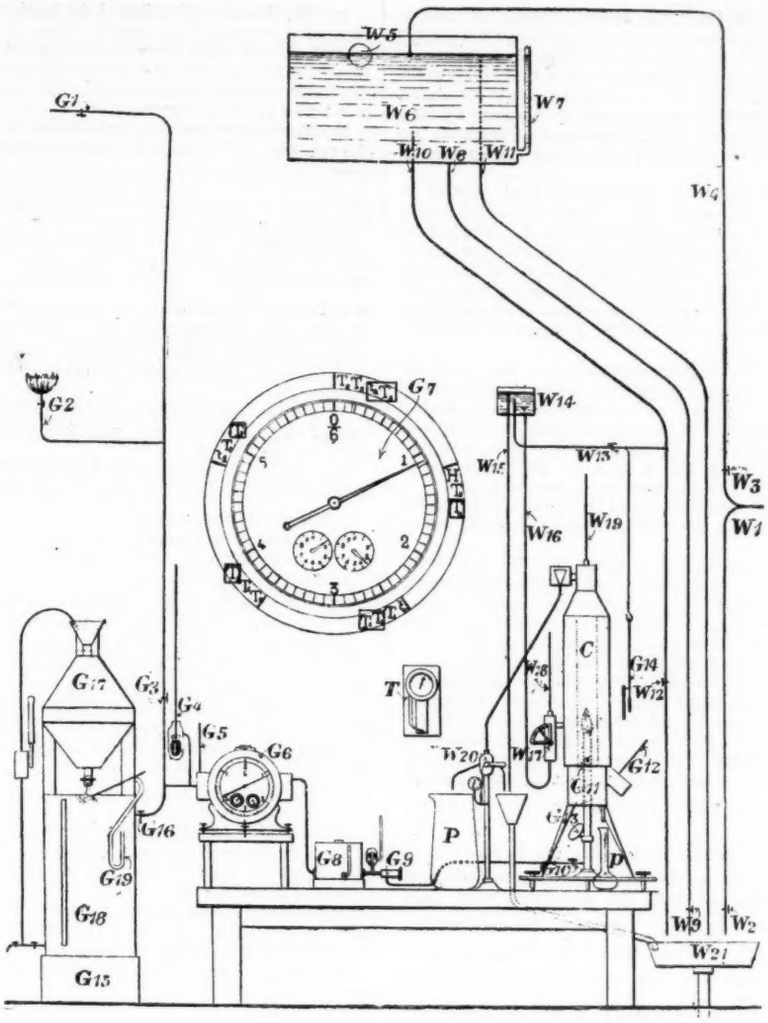
8. The water for the calorimeter is derived from the main supply which, as required, allows a good stream of water to be run down the sink by the tap W2. A branch pipe fitted with a tap, W3, leads to a tank fitted with a ball (float) valve. The branch pipe is lagged, so as to keep the water at the temperature of the town supply.

The tank, provided with a levelling gauge, W7, is placed in the testing room. It has three separate pipes communicating with the sink. One, W8, for cleaning, starts from the lowest point in the tank, and is controlled by a tap, W9, which serves no other purpose. Another, W10, for the supply of the water to the calorimeter, starts an inch or two from the bottom of the tank. The flow of water is regulated by a tap, W12, placed in its lower part conveniently to hand. The third, W11, is an overflow pipe as a safeguard against any failure of the ball-valve. The capacity of the tank—that is the volume from the maximum level given by the ball-valve to the lowest level obtainable with the supply-pipe—should exceed 200 litres.

The adjustment of the ball-valve requires to be such that, at the maximum water-level, there is complete cut-off of the supply to the tank, and that for a reduction of this level by more than 6cm. the rate of such supply by W4 should be greater than the rate of supply from the tank by the pipe W10, at the full opening of the tap W12 in the latter—say, 40 litres per minute.

A branch from the supply pipe is the feed-pipe proper for the calorimeter, and is controlled by a screw tap W13. These two pipes are well lagged, for the maintenance of the water at the same temperature as that in the tank.

Beyond the screw tap, the water passing to the calorimeter reaches a small cylindrical reservoir, W14, fitted with an over-



The letters G and W refer to gas and water respectively—the numerical order representing approximately the passage of the gas (or water) through the apparatus.

SUPPLY OF GAS TO CALORIMETER.

G 1. Pipe, with tap, supplying gas for test.
G 2. Branch with "permanent burner."
G 3. Tap supplying gas to calorimeter system.
G 4. Mano-barometer.
G 5. Thermometer t_e at inlet to meter.
G 6. Meter (wet), fitted with spherical level.
G 7. Meter dial, enlarged scale. [The marks shown with a line around them are in red on the instrument.]
G 8. Pressure regulator, with level gauge.
G 9. Screw-down tap.
G10. Tap of calorimeter burner.
G11. Calorimeter burner.
G12. Thermometer t_g for temperature of products of combustion at outlet of calorimeter.
G13. Mirror for adjustment of gas-flame.
G14. Thermometer t_a placed about 2 in. from the calorimeter.
C. Combustion tube of calorimeter.
p. Vessel receiving water from the combustion of gas.
G15. Meter-prover.
G16. ,, tap in branch pipe to.
G17. ,, gauged reservoir.
G18. ,, gasholder.
G19. ,, pressure gauge.

T. Indicator of temperature of testing room near calorimeter.

SUPPLY OF WATER TO CALORIMETER.

W 1. Water supply pipe.
W 2. Tap for flushing main water supply.
W 3. Tap for supplying calorimeter system.
W 4. Supply pipe to calorimeter tank.
W 5. Ball-valve water-inlet to tank.
W 6. Tank.
W 7. Tank level-gauge.
W 8. Pipe from base of tank to sink.
W 9. Tap on tank-sink pipe.
W10. Pipe to calorimeter reservoir.
W11. Overflow pipe.
W12. Tap for hand-control of supply by W1c.
W13. Screw-tap on branch of W10.
W14. Cylindrical reservoir.
W15. Overflow pipe of reservoir, W14.
W16. Feed pipe from reservoir to calorimeter.
W17. Graduated tap for water inlet to calorimeter.
W18. Thermometer T_e at water inlet.
W19. ,, T_s at water outlet.
W20. Two-way tap, also operating the stop-clock.
P. Vessel receiving water from the calorimeter.
W21. Sink.

flow. It falls from it by a vertical metal tube of constant length, and reaches the graduated tap, W17.

The opening of this tap remains the same during the tests, and should correspond with the passing of 1300 grams. of water per minute.

9. The general arrangements in the testing room are designed for convenience in carrying out the measurements. The calorimeter and accessory appliances are mounted on a levelled table, about 18 in. above the floor. The meter is on a levelled table about 30 in. high.

The water which has passed through the condenser of the calorimeter, and has been collected in the vessel P, is weighed in a balance sensitive to 1 gram. The vessel P (of glass) is marked with its weight; and for each of such vessels used in the tests, a metal tare weight (marked with its value in grams.) is provided. That for the vessel P in actual use is kept permanently on one of the pans of the balance.

A clock—recording seconds and started and stopped by the operation of the two-way tap—measures the time occupied in the passing of the afterwards weighed quantity of water.

The glass vessel *p*, in which is collected the water from the products of combustion, is graduated in calories by means of the formula given in paragraph 2. Thus 1 c.c., or 1 gram., of condensed water corresponds with 4·94 calories.

A table and slide-rule, kept in the testing room, are used in correcting the observations for temperature, pressure, and meter-error referred to in a previous paragraph. The testing room also contains spare glass vessels, spare thermometers, as well as those

for checking the readings of the meter and the supply of water to the calorimeter; a 24-litre clepsydra or meter-prover, with pump; also general requisites such as plugs, grease, funnels, &c.

Every care is taken to keep the temperature of the testing room constant during the test. The room is appropriately ventilated and heated, so that the average temperature is between 15° and 18° C. It is fitted with an indicator T showing at a distance the temperature of the part of the room where the calorimeter is placed.

10. In making preparations for the test, the first step is to check the working of the gas apparatus. The main tap supplying the gas is opened, and the permanent burner lighted. The burner tap of the calorimeter is opened, and the pressure in the meter allowed to adjust itself. Note is made that the level of the water at the regulator or governor is at the height of the register mark, and that the zero mark on the manometer or pressure-gauge scale is properly placed. The latter is rectified if necessary, and the burner tap then closed.

The gas supply tap (G3) is then opened, and the governor blocked. After a few seconds, the positions of the pointers on the meter are noted. These pointers should remain motionless during the whole of the time employed in checking the gas apparatus and in adjusting that for the water. If they do not, there is a leak which must be stopped, or, if this cannot be done, the test is suspended and the condition of the apparatus reported.

The meter carries a spherical level, and is supported on screw feet. Its horizontal position is checked, and if found necessary readjusted.

11. In preparing the water apparatus, the tank is first filled from the town supply and the tap W3 of its supply pipe set full open. The working of the apparatus is then checked as follows:

The two-way tap is set so as to discharge water into the sink. The screw tap supplying water to the calorimeter is opened. The overflow placed above the calorimeter should be discharging during the whole period of the test. Any leak of water at the screw joints, taps, or rubber connections is remedied. By means of the seconds stop-clock, and by weighing, the delivery of water by the graduated tap at the rate of 1300 grams. per minute is checked, and the exact placing of the thermometers—particularly T_e and T_s—is seen to, or rectified, if necessary. A note is made of the maker's numbers engraved on the thermometers T_e and T_s, and of the number of the gas-meter.

12. When adjusting the water, the temperature T_e of water at the inlet to the calorimeter is noted. It is important to bring and to keep T_e at a figure 4° (within about half-a-degree) lower than the prevailing temperature t_a. This condition—in conjunction with the condition $T_s = T_e + 8°$, referred to in paragraph 13—tends to nullify any exchange of heat between the calorimeter and the surrounding atmosphere.

Usually, at the outset, the water in the tank is too warm. In this case, it is cooled by means of water at a lower temperature drawn from the town supply. For this purpose the supply pipe (W12) is operated. The tank is kept full by the action of the ball-valve.

In the course of a test T_e tends to rise. It is kept, as first adjusted, by operating the tap (W12) and, if necessary, the screw tap of the calorimeter. If T_e cannot be adjusted as specified above, a note is made of the fact with the other entries and the test proceeded with.

13. The adjustment of the gas is done by first opening the burner tap and lighting the gas. The screw-down tap should be kept as set during the preceding test.

The burner is placed under the calorimeter, and its flame adjusted. If necessary, the screw-down tap is operated so that the temperature T_s is lower than $(T_e + 16°)$. The governor is deblocked, and a look given to the maintenance of the pressure at 20 mm. Then the operator should wait till the first drops of condensed water appear, and collect them in a spare vessel. At this moment, the screw-down tap G9 is operated so as to adjust T_s at a point equal to $(T_e + 8°)$ to within a quarter of a degree.

The effect of each movement of the tap is not instantaneous, and requires for its production, the consumption of 3 litres of gas. The practice is to make successive trials, at intervals represented by the consumption of at least 3 litres of gas.

The temperature T_s, having been once adjusted, it is kept constant during the consumption of at least 6 litres of gas before beginning the test.

The vessels P and p are cleaned, the tare weight of P on the balance pan is checked, and the vessel P placed in position under the two-way tap.

Operations in Making the Test.

14. In making the allowance for the heat corresponding with the condensed water, the receiver p is substituted for the spare vessel just as the larger pointer of the meter passes the zero mark. A note is made of the positions of the small pointers and of the time.

When the meter indicates a total consumption of 120 litres of gas, the receiver p is withdrawn; the time is again noted; and the test is ended. A reading is then taken on the graduated part of the receiver p of the calories, per cubic metre of gas burnt, resulting from the condensation.

15. For the determination of the total or gross heat of combustion, after burning 6, 48, and 90 litres of gas, the two-way tap is turned so that water flows into the vessel P. The reverse operation is performed after two turns of the wheel. The weight P of the water collected in the vessel thus corresponds with the combustion of 12 litres of gas.

During this combustion a record is taken, in accordance with the readings on the meter, of the temperature T_e (three times), of T_s (ten times), of t_c, t_a and t_g (once each). In paragraphs 18 and 19 are given the calculations, by the aid of these data, of the total heat produced by the combustion.

The marks in black on the meter dial are those corresponding with the first revolution of the pointer; those in red, with the second revolution. In the distribution, the readings of T_e are in advance of the readings of T_s, in order to make allowance for the time taken by the water to traverse the calorimeter.

As soon as the weight P has been obtained on the balance, the vessel is emptied, cleaned, and dried, and placed in readiness for the next test.

16. All the readings should, at the time they are made, be entered in full on the test schedule, a specimen of which (with entries) is appended.

The degrees of accuracy with which the readings or measurements should be made are respectively as follows:

Weight of P, to 1 gram.
Receiver p, to 1 calorie.
Thermometers T_e and T_s, to within one-hundredth (0·01) of a degree Centigrade.
Other temperatures, to within one-tenth (0·1) of a degree C.
Pressures, to within one millimetre of water or mercury.

17. The test having been completed, the burner tap is closed, and the burner withdrawn from the calorimeter. The gas-supply tap (G3), and that of the permanent burner are closed.

Of the water system, the screw tap and the supply tap (W12) are closed and the tank supply tap W3 fully opened.

Weights and other equipment are put in order and the main gas-supply tap G1 closed.

Calculations from the Observations.

18. In arriving at the mean and corrected figures for the calculation of the calorific power, the relative value of the last significant figure for each quantity to be entered on the schedule is indicated in the tables.

In the calculations, the results are rounded-off by adopting the next higher value when the last figure is 5 or greater than 5, or by neglecting the last figure in the opposite case.

The mean values are calculated for all the readings of P, T_e, T_s, t_c, t_a, t_g and H.

P/12 is expressed in decigrams.

The means of T_e and T_s are expressed in thousandths of a degree, and are corrected from the tables drawn up for the various thermometers.

The difference between the two thermometers, T_e and T_s is thus corrected. To this difference is added the quantity + 0·006 printed on the schedule and due more to the constant difference of outside pressure to which the two thermometers are subjected than to the fact that the columns of mercury are partly in the air, instead of wholly in the water. The quantity $(T_s - T_e)$ is then rounded off to the one-hundredth of a degree.

The means of t_a and t_g are expressed in tenths of a degree Centigrade and the mean of t_c in hundredths of a degree.

In order to allow for possible errors in the meter, the temperature t_c is corrected from the number obtained by the last check of the meter. [See paragraph No. 23.]

It is important not to overlook the sign (*plus* or *minus*) of the correction. The calculation to be employed in rounding-off to a tenth of a degree the corrected temperature t_c, is given in paragraph No. 19.

The mean value of H is expressed in millimetres of mercury.

19. In the calculation of the gross number of calories, as already stated in paragraphs Nos. 2 and 3, the total heat of combustion of 1 cubic metre of gas is $\frac{P}{12}\left(T_s - T_e\right)$, and is expressed as a whole number of calories. From this is deducted the quantity p in order to obtain the net calorific power for 1 cubic metre of gas, saturated with moisture, at temperature t_c and pressure H, and including the error due to the meter.

In order to obtain the figure for the calorific power under normal conditions, it is necessary to apply the requisite corrections from a table or else by means of a special slide rule for the values of H and t_c (*corrected*).

If the table is adopted, there is found in it the value of the correction factor for the temperature and pressure applying to the gas. The uncorrected calorific power multiplied by this factor is the calorific power corrected to normal conditions.

In the use of the slide-rule, the point on the scale corresponding with H is brought opposite the point corresponding with t_c (*corrected*). Then opposite the point on the scale corresponding with

the value of the uncorrected calorific power will be found the corrected figure.

The corrected calorific power is expressed as a whole number of multiples of ten calories per cubic metre.

20. The correctness, or rather the departure from correctness, of the meter is ascertained by the means of the clepsydra or meter-prover, which is used for this purpose without disturbing the apparatus, in a special test made once for about every twenty-five of the ordinary determinations. The test is also undertaken before taking into use any meter which has been adjusted or repaired or has been provided with a fresh supply of water.

The permanent burner is lighted, and the gas-supply taps to the burner and meter-prover are opened. The governor is blocked, and the meter caused to make at least two revolutions. The burner tap is then closed.

The gasholder of the meter-prover should have been left full of water from the previous test. This water is raised into the upper reservoir G17 so as to fill the reservoir just above the register mark. The gas has then displaced the water within the holder. The taps emptying the meter-prover of water and delivering the gas are then closed. The pressure-gauge on the meter-prover indicates the pressure of distribution.

To be sure there is no leakage, the gauge should not show a variation of 1 mm. pressure in five minutes. The horizontal setting of the meter should also be tested, and, if necessary, an adjustment made.

The screw-down tap G9 is fully opened. The burner tap is opened, and the residual pressure in the meter-prover noted. If this is greater than 3 mm., the meter is in need of repair.

A little water is now caused to flow from the reservoir in order to bring the level of the water exactly to the height of the register mark. The water apparatus is checked as directed in paragraph No. 11. By opening the screw-tap W13, water is caused to pass through the calorimeter at the rate of 1300 grams. per minute.

21. In now testing the meter, the position of the pointers is noted, reading the litres on the "total" scale, and the fractions of a litre on the large scale. By lighting the burner and placing it in position in the calorimeter, the 24 litres of gas are caused to pass from the reservoir. Following the movements of the pointers on the meter, note is made at the commencement, towards the middle, and near the end of the 24 litres, of the readings of the pressure gauge on the meter-prover and of the thermometers t_c (G5) of the meter, t_a (G14) of the room and of a thermometer t_{cl}, placed in the cup of the meter-prover. This thermometer t_{cl} may be the same as that used at the outlet of the gas on the calorimeter and is removed for its present purpose. The mean of the readings is taken. If there is a greater difference than 1° between two of the mean temperatures t_c t_a t_{cl}, the test should be repeated on a further occasion.

The same course is adopted if the mean pressure in the meter-prover exceeds 10 mm. In this case, during the action of the meter-prover a note is made of the reading of the governor pressure-gauge. If the pressure recorded by it is greater than 5 mm. of water, the burner should be sent away for repair. If the difference between the pressures read at the gauges of the meter-prover and governor is greater than 5 mm., the meter should be removed for repair.

The meter-prover is constructed for a duration of flow of water of about twelve minutes. This time should be recorded by the seconds stop-clock. When the reservoir is empty, the meter stops. As already directed, the position of the pointers and the residual pressure (below 3 mm.) are noted, and the difference in the meter readings calculated. The meter readings are made to within the one-hundredth of a litre; those of the other instruments, in accordance with the standards stated in paragraph No. 16.

22. Three tests are first made. If two of the volumes of gas recorded by the meter differ by more than 0·08 litre, the tests are continued until three successive volumes are obtained differing by not more than 0·08 litre. The test is then ended, the governor deblocked, and the taps of the meter-prover and permanent burner closed. The calorimeter burner is put in place and its action brought to an end, as directed in paragraph No. 17.

23. For the calculation of the correction requiring to be applied to the meter readings, the mean is taken of the volumes recorded by the meter, rounding these off to the hundredth of a litre as in paragraph No. 18. On subtracting 24 litres from this mean, the remainder is the actual error e of the meter. The temperature correction [paragraph No. 18] is, with its sign, equal to $8{\cdot}5\,e$.

24. It is necessary at times to re-adjust the level of the water in the meter. When the actual error e of the meter exceeds 0·20 litre the level of the water is restored by altering the quantity of water contained in the meter by an amount equal to $500\,e$ grams. If the error is negative, as it most generally is, the quantity of water just indicated is introduced into the meter; if the error is positive, water is withdrawn. The meter then requires to be again tested for reduction of its error to below 0·12 litre. If the error obtained in the final test is still greater than 0·12 litre, the meter should be sent away for repair and replaced by another.

25. In the maintenance of the thermometers employed in the tests, the precision instruments T_e and T_s are sent every two years, or more frequently if necessary, to the Municipal Lighting Laboratory for checking and for the drawing up (if required) of fresh correction tables.

Typical Schedule of Test of Calorific Power of Gas Made at 9 p.m., Sept. 3, 1913, at the Testing-Station, No. 3, Rue Poulletier.

Water: Test on 12 Litres of Gas.

Setting (opening) of Graduated Tap, 63°.

Thermometer Readings. T_c, water inlet, No. 32,743. T_s, water outlet, No. 32,744.			Corrected Temperatures °C.
I	II	III	
1. At outlet of calorimeter, T_s			
19·53	19·40	19·40	
19·42	19·35	19·35	
19·34	19·38	19·32	
19·50	19·35	19·42	
19·45	19·31	19·42	
19·40	19·40	19·46	
19·42	19·36	19·38	
19·34	19·35	19·41	
19·32	19·40	19·45	
19·40	19·30	19·48	
194·12	193·60	194·09	
Grand total		581·81	
Mean		19·394	19·402
Correction		+ 0·008	
2. At inlet of calorimeter, T_e			
11·28	11·22	11·18	
11·25	11·20	11·18	
11·25	11·20	11·18	
33·78	33·62	33·54	
Grand total		100·94	
Mean		11·216	11·280
Correction		+ 0·064	
Difference (rise in temp') .		8·122	
Add constant correction		0·006	
$T_s - T_e$		8 13	

Gas: Meter No. 1,413 577.

Combustion of 120 litres.	Times.	Litres on Meter.	Temperatures read on the Thermometers in Degrees Centigrade. At Meter t_c	At outlet of Burnt Gas t_g	Prevailing t_a	Pressures in Millimetres of Mercury. (Manobarometer.)
	hrs. mins.					
Started . . .	21 03	35				
I Start + 6 litres		41	14·8	13·5	14·5	756
II ,, + 48 ,,		83	14·7	13·5	14·4	755
III ,, + 90 ,,		25	14·7	13·4	14·5	755
End. ,, + 120 ,,	22 06	55				
		Totals .	44·2	40·4	43·4	2266
Time . . .	63					
		Mean .	14·73	13·5	14·5	755
Correction for meter (check of Sept. 1, 1913)			+0·60			
Total . . .			15·3			

Weight of Heated Water, P.	Grams.	Time. Seconds.
I	7358	376
II	7395	378
III	7443	380
Total . .	22196	
Total $\frac{P}{36} = \frac{P}{12} =$.	616·6	

CALCULATION OF CALORIES.

1. Gross total heat per cubic metre $= \frac{P}{12}(T_s - T)$	5013
Deduct	
2. Heat of condensation	461
Calorific power, uncorrected—*i.e.*, at 15·3°C and 755 mm.	4552
3. Corrected calorific power	4920

At the testing station itself a check is made every year of the general agreement of the thermometers. For this purpose the bulbs of the instruments are placed simultaneously in water contained in a special box, above which is a support which holds the thermometers so that their bulbs are nowhere in contact with the sides of the box. The water in the box is kept in movement by means of a stirrer. At the end of five minutes, readings are taken of the thermometers, T_e, T_s, t_c, t_a, t_g, t_{cl}. After correction, in accordance with the respective tables, the readings of T_e and T_s are rounded-off to the hundredth of a degree. They should not differ by more than 0·03°. If they do, the two thermometers are replaced by others taken from the stock of the Municipal Lighting Laboratory.

The mean of the corrected readings T_e and T_s is taken and rounded-off to one-tenth of a degree. The reading of each of the other thermometers should not differ by more than 0·5° from this mean. If any does so differ, the defective thermometer is taken out of service at the testing station and returned to the Lighting Laboratory. If necessary, it is replaced by a fresh instrument in proper condition.

26. The calorimeter is examined about every three months, after a test has been made of the meter. The examination should extend in particular to the surface of the tubes which are exposed to the burnt gases. In no case should the threaded ring which holds the lower connection be disconnected.

At the same time a general examination is made of the good state of other parts of the installation, and the tank is completely emptied by the tap connecting it directly with the sink.

In the event of one of the glass receivers P being put out of use, the tare weight corresponding with it is immediately removed from the testing station.

Typical Schedule of Check on Meter (No. 1,413,577) Made at 2 p.m., Sept. 1, 1913, at the Testing-Station, No. 3, Rue Poulletier.

No. of Test.	During Test on 24 Litres.				Before and after Test on 24 Litres.					Notes.
	Temperature in Degrees Centigrade.			Pressure in Clepsydra in mm. of Water.	Readings Taken.	Residual Pressure in Clepsydra in mm. of Water.	Time of Flow of Water.	Litres on Meter.		
	At Meter t_c	Prevailing t_a.	At Clepsydra t_{cl}					Readings.	Differences.	
							Min. Sec.			
I.	15·3	16·4	15·6	9	Start .	2	..	18·43	..	Error = 24·27 − 24·00 = 0·27
	15·3	16·4	15·7	8	End .	2	11 37	42·70	24·27	Drawn from meter:—
	15·4	16·4	15·7	7						500 grams. × 0·27 = 135 grams.
Mean . .	15·3	16·4	15·7	8						
II.	15·4	16·4	15·7	9	Start .	2	..	51·75	..	Discarded: Error greater than 0·08 litre against Test No. III.
	15·4	16·4	15·7	8	End .	2	11 37	75·69	23·94	
	15·5	16·5	15·8	7						
Mean . .	15·4	16·4	15·7	8						
III.	15·6	15·5	15·7	9	Start .	2	..	84·50	..	
	15·6	15·6	15·7	8	End .	2	11 38	08·57	24·07	
	15·6	15·6	15·8	8						
Mean . .	15·6	15·6	15·7	8						
IV.	15·6	16·6	15·8	9	Start .	2	..	13·89	..	
	15·7	16·6	15·8	8	End .	2	11 37	47·95	24·06	
	15·7	16·6	15·8	7						
Mean . .	15·7	16·6	15·8	8						
V.	15·7	16·6	15·8	9	Start .	2	..	51·20	..	
	15·7	16·6	15·9	8	End .	2	11 38	75·27	24·07	
	15·8	16·7	15·9	8						
Mean . .	15·7	16·6	15·9	8						
VI.					Start .					
					End .					
Mean . .										
					Total of Tests Nos. III., IV., and V.				72·20	Value of *correction*, due to error of meter, and for use in calculating calorific power.
					Mean				24·07	$8·5\,e = +\,0·60$.
					Error (against 24 litres) e				+ 0·07	

Typical Schedule of Tests for Error of Thermometers, Made at 1 p.m. Sept. 1, 1913, at the Testing-Station, No. 3, Rue Poulletier.

Positions of Thermometers.	Maker's No.	Readings and Corrections.	Temperatures Corrected.	Error.	Notes.
On calorimeter: Water inlet . . . . . T_e	32,743	17·78 + 0·067	17·85	0·01	Good
On calorimeter: Water outlet . . . . . T_s	32,744	17·88 − 0·022	17·86		
On calorimeter: Mean temperature . . .			17·9		
			Difference from mean temperature.		
On calorimeter: Outlet, burnt gas . . . t_g	44,114−2	17·7	0·2		Good
On gas-meter . . . . . t_c	44,106−1	17·8	0·1		Good
Prevailing in test-room . . . . . t_a	44,119−3	17·8	0·1		Good
On clepsydra . . . . . t_{cl}	44,120−4	18.0	0·1		Good

In the course of a discussion on fuel economy at the Midland Institute of Mining Engineers' meeting in Leeds last week, Mr. J. A. Yeadon said they could not afford, after the war, to let waste material be thrown upon the pit-heap to fire itself. The actual cost at the present time of making briquettes—including the pitch, motive power, steam, and grease, with 15 p.ct. on the capital for interest and depreciation—was 2s. 9d. per ton for a fifty-ton plant. It had been found on a practical trial that, weight for weight, the briquettes gave more heat than coal. He mentioned that briquettes containing 45 p.ct. of coal, 45 p.ct. of chalk, and 10 p.ct. of pitch were being used successfully for steam-raising purposes.

SOME PHYSICO-CHEMICAL CONSIDERATIONS ON BENZOL RECOVERY FROM COAL-GAS.

By T. F. E. RHEAD, M.Sc., of the Central Laboratory, Gas Department, Birmingham.

[A Paper read before the Midland Junior Gas Association, Jan. 25.]

The purpose of this paper is to discuss, from the physico chemical standpoint, the problem of the extraction of crude benzol from coal gas, using creosote oil as a washing medium, and also to record the effect of the viscosity, temperature, and composition of the creosote, on this problem. It is hoped that the following brief review of the kinetic theory of matter—explaining why liquids exert vapour pressures and dissolve gases—will help to give a clear conception of the washing process.

The kinetic theory assumes that all substances—solid, liquid, and gaseous—are composed of innumerable small particles called molecules. These molecules are not in actual contact with one another, but are in close proximity; the space separating them increasing as the substance is caused to pass from the solid to the liquid and thence to the gaseous state. This increase of intermolecular space is revealed by the expansion of the substance. Broadly speaking, molecules possess two forms of energy—molecular and heat energy. Molecular energy exists in the molecule; and one of its rôles is to exert a force of attraction on other molecules. Heat-energy produces a translatory motion of the molecules. For a substance in the solid state the force of molecular attraction prevents the molecules having much freedom of motion or mobility; but as heat energy is added to the substance, the effect of molecular attraction decreases. The molecules thereby acquire increased mobility; and the liquid state results. Still further addition of heat energy more or less completely nullifies the effect of molecular attraction; and the substance assumes the gaseous state, in which the molecules seem to lead a fairly independent existence. They appear to move with great velocity in straight lines, frequently colliding with one another and bombarding the walls of the containing vessel, producing what is called the pressure of a gas. The relative motion of the molecules of a substance enables them to travel about in this substance or into surrounding substances in any direction uninfluenced by gravity. This wandering of molecules is called diffusion; and it takes place to a very limited degree in solids, to a greater degree in liquids, and to a very much greater degree in gases.

The reason liquids exert vapour pressures is explained as follows: The molecules of a liquid, being in a state of motion, frequently collide with one another, and, consequently, there are always a certain number of them moving much faster than others. The high speed of the faster moving molecules in the surface of a liquid enables them to break-away from their neighbours, and to pass into the space above the liquid as free gas molecules. If these molecules move away unhindered, others take their place, and the liquid will continue to give off gas molecules until it is completely evaporated. If, however, the liquid is kept in a closed space, the molecules which leave its surface will only be able to travel as far as the walls of this space, and must eventually return in the direction of the liquid. It will consequently happen that some of them will strike the surface of the liquid again and be retained by it—they are said to condense. Thus, at one and the same time there are some molecules leaving the surface and others entering it; and the liquid will continue to evaporate until the number entering the surface is equal to the number leaving it in unit time. When this equilibrium is established, the pressure of the gaseous molecules is called the maximum vapour pressure of the liquid at that temperature, and the space is said to be saturated with the vapour. The number of molecules able to break-away from unit surface in unit time increases with rise of temperature. Consequently the maximum vapour pressure exerted by a liquid increases with rise of temperature.

The average velocity of all the molecules of a liquid at any temperature is called their "mean velocity" at that temperature, and varies for different liquids. Therefore, different liquids exert different vapour pressures at the same temperature, and for a mixture of liquids the molecules of the different components have different mean velocities, and those components with the higher velocities will evaporate quicker than the others, causing a fractionation of the mixture. To a much smaller extent the molecules on the surface of solids can break-away into surrounding space and exert vapour pressures. Due to this cause, such solids can evaporate without passing through the liquid state, or pass directly from the gaseous to the solid state. They are said to sublime. Naphthalene is a well-known example.

The solubility of gases in liquids which have no chemical action on them is accounted for as follows: The gaseous molecules impinging on the surface of the liquid may be held there by the attraction of the molecules of the liquid; and as the number of these dissolved molecules increases in the liquid, some of them will fly out from the surface again, and in time an equilibrium will be established. The liquid is then said to be saturated with the gas at that pressure. Since the attraction exerted by the molecules of any solvent on the molecules of different gases is a varying quantity, so the solvent action differs—some gases being more soluble than others. For a given quantity of gas, the number of molecules striking unit surface of a liquid exposed to it is proportional to the pressure. This relationship was put into a law by Henry, for gases only moderately soluble in a solvent—viz., "a given quantity of liquid will dissolve at constant temperatures quantities by weight of the gas which are proportional to the pressure of the gas."

When a solvent is exposed to a mixture of gases, each dissolves in the liquid as if all the others were absent. Dalton put this relationship into the form of a law, which states "that when a mixture of moderately soluble gases dissolves in a liquid, each component dissolves according to its own partial pressure." Both Henry's and Dalton's law assumes that there is no true chemical action between the gases and solvents.

VAPOUR PRESSURES OF MIXED LIQUIDS.

When two liquids A and B are shaken up together, the question of miscibility depends on the attraction of unlike molecules for one another. If this attraction is negligible compared with that of the like molecules for one another, the liquids will not mix—*e.g.*, benzene and water; if it is rather slight, they will partially mix—*e.g.*, carbolic acid and water; and as the mutual attraction increases, complete miscibility is obtained—*e.g.*, benzene and toluene. If two or more non-mixing liquids are placed in an enclosed space the resultant vapour pressure is equal to the sum of the vapour pressures which they would exert separately—each liquid behaves independently of the other, for all practical purposes. With two partially miscible liquids, the vapour pressure is found to be less than the sum of the components, but greater than either one singly, at the same temperature. With liquids which are completely miscible, no generalization is possible, as many different cases arise. Some liquids when mixed in certain proportions give a higher or lower vapour pressure than for other proportions; and for this reason such mixtures cannot be separated by distillation. They form "constant boiling mixtures." This probably happens with pre-benzol constituents and benzene, which are extremely difficult to separate in refractionation. When two liquids are closely related chemically, the resulting vapour pressure is often given by the relationship—

$$P = \frac{m}{100} P_a + \frac{(100-m)}{100} P_b \qquad (1)$$

Where P = vapour pressure of mixture, P_a that of A, and P_b that of B, all at the same temperature, m = the molecular percentage of A in the mixture.

SOLUBILITY IN CREOSOTE OF COAL-GAS CONSTITUENTS.

The bulk of the compounds in creosote are chemically closely related to the benzol, toluol, and solvent naphtha contained in coal gas; so when these vapours dissolve in creosote the vapour pressure of the dilute solutions may fairly safely be calculated from the above formula. By substituting in the formula the vapour pressures of the creosote and those of small percentages of benzol, toluol, and solvent naphtha, either separately or mixed, the writer has found calculated values agree fairly well with observed ones. [Several vapour pressure measurements have been made by the method given in the Appendix.]

This means, then, that for the dilute solutions met with in practice, of washable products of coal gas dissolved in creosote, each dissolved body exerts a fraction of its own maximum vapour pressure at that temperature, equivalent to the percentage in which it occurs in the creosote—*e.g.*, pure benzene has a vapour pressure of 75 m.m. at 20° C., and therefore a 5 p.ct. solution in creosote, at 20° C., would exert a benzene vapour pressure of $5 \div 100 \times 75 = 3{\cdot}75$ m.m. Most of the constituents of coal gas when compared with the vapours of the liquid hydrocarbons benzol, toluol, solvent naphtha, and low boiling paraffins are practically insoluble in creosote. The relative quantities of these soluble vapours in purified coal gas depend on the type of coal from which the gas was made, the temperature and system of carbonization, and the temperature of the gas when last in contact with its own tar.

For the purpose of illustration, one particular gas is taken which contained 3 gallons of washable products per 12,000 c.ft.—*i.e.*, per ton of coal—in the following proportions:

TABLE I.

Pre-benzol (products lower boiling than benzol)	0·06 gall.	per	ton = 2	p.ct.	washable products.
Benzol	2·16	,,	,, 72	,,	,,
Toluol	0·51	,,	,, 17	,,	,,
Solvent naphtha	0·27	,,	,, 9	,,	,,

NOTE.—Solvent naphtha, of course, is a mixture of aromatic hydrocarbons.

The composition of the pre-benzol is not definitely known; but it contains carbon disulphide and low-boiling paraffin hydrocarbons—probably butane, pentane, hexane, hexylene, &c. Its high specific gravity points to a considerable amount of CS_2 and allied bodies; and if it be assumed to have a molecular weight equal to that of a mixture of pentane, hexane, and CS_2 in equal proportions, it will not be seriously out from the point of view of the present argument. Taking into account the fact that the molecular weight of a gas in grams. occupies 22·38 litres at 0° C. and 760 m.m., we

can calculate the percentage volume in coal gas of the above constituents, and also the partial pressures. For the gas under consideration, they are as shown in Table II.

TABLE II.

	Percentage in Gas by Volume. P.ct.		Partial Pressure in m.m. of Mercury.
Pre-benzol	0.022	..	0·165
Benzol	0·773	..	5·880
Toluol	0·152	..	1·158
Solvent naphtha	0·069	..	0·528
	1·016		7·731

From the vapour pressure curves (fig. 1) can be calculated approximately the percentage of these constituents which the gas

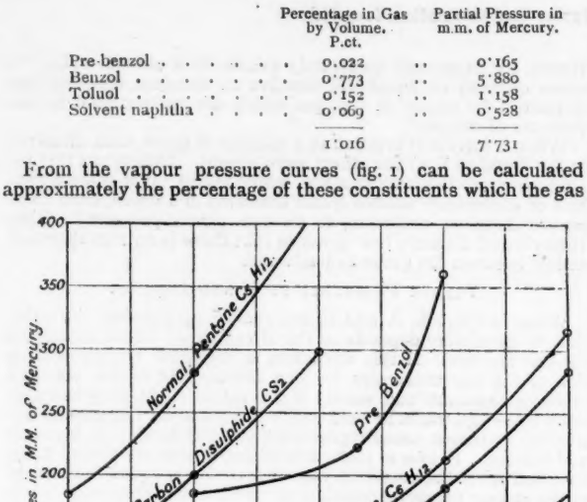


Fig. 1.—Vapour Pressures of Liquids.

could carry if saturated. The curves for pre-benzol, crude benzol (less residue above 160° C.), solvent naphtha, and xylene were determined by the method given in the appendix. The other curves are from well-known tables of vapour pressures (Landolt & Börnstein). The curves for the pre-benzol and crude benzol will differ according to their composition.

A coal gas saturated at 15° C. could carry the following quantities:

TABLE III.

	Percentage in Gas by Volume. p.ct.		Partial Pressure in mm. of Mercury.		Equivalent Gallons per 12,000 c.ft.
Pre-benzol	25·6	..	195	..	71
Benzol	8·0	..	60	..	22
Toluol	1·84	..	14	..	6·16
Solvent naphtha	0·53	..	4	..	2·04

If creosote wash-oil were exposed to a constant supply of coal gas containing 3 gallons of washable products in the foregoing quantities per 12,000 c.ft. of gas, it would continue to dissolve them until the solution of each one had a vapour pressure equal to its partial pressure in the gas.

The percentage of each washable product which when dissolved in creosote gives a vapour pressure equal to the partial pressure of that product in the gas can be calculated from the vapour pressure curves (fig. 1). The vapour pressure of benzene at 20° C. is 75 mm., and its partial pressure in the gas is 5·88 mm. —*i.e.*, 75 mm. pressure is exerted by 100 p.ct. of benzol; therefore, 5·88 mm. pressure is exerted by 7·84 p.ct. of benzol [see equation 1]. This means that a creosote containing 7·84 p.ct. of benzene would have a vapour pressure, with respect to benzene at 20° C., of 5·88 mm. Obviously the above gas passing through such a solution at 20° C. would lose none of its benzene—the creosote has reached its saturation limit for benzene with respect to this particular gas at 20° C.

In the following table the saturation limits of creosote are given at different temperatures for pre-benzol, benzol, toluol, and solvent naphtha for the gas in question.

TABLE IV.

Washable Product.	Vapour Pressure of Washable Products in Solution.	Percentage of Washable Product in Solution to give Vapour Pressure in Column Two.						
		10° C.	15° C.	20° C.	25° C.	30° C.	35° C.	40° C.
	M.m.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
Pre-benzol	0·165	—	·084	·079	·069	·045	—	—
Benzol	5 880	—	9·8	7·84	6·2	5·0	4·0	3·2
Toluol	1·158	—	8 27	5·5	4·1	3·2	2·46	1·93
Solvent naphtha	0·528	—	13·2	8·8	6·6	4·4	3·1	2·3

For a temperature of (say) 20° C., it will be seen the creosote can dissolve 0·84 time as much toluol as benzol and 1·34 times as much solvent naphtha. The quantities of gas containing these relative amounts are in the ratio B : T : SN : : 1 : 3·55 : 10·7, which means that the creosote can wash the toluene from 3·55 times the gas which saturates it with respect to benzene, and the solvent naphtha from 10·7 times the same amount. This point was made use of on some works in the early days of the war when only the toluol and solvent naphtha were required. The gas was washed with only just sufficient oil per ton to dissolve-out the toluol and solvent naphtha, and consequently left a considerable amount of benzol in the gas, and saved re-enriching the gas. The saturation limits enable one to see to what extent it would be necessary to benzolize the wash-oil before using, in order not to extract any benzol from the gas.

It is generally found that the rate of absorption of gases by liquids (assuming there is no chemical action) is proportional to the difference between the concentration of the gas in the solution at its saturation point and to its concentration in the solution at the moment of measurement. What bearing has this on the relative rates of absorption of washable products in coal-gas by creosote? Consider the "inlet gas" part of the washer, because at that point the partial pressures of washable products in gas are known, and, consequently, the saturation limits of creosote under those conditions. If 100 gallons of creosote per ton are being used for washing a gas of the above composition, and complete extraction of washable products effected, then the creosote about to leave the washer, coming into contact with unwashed gas, will contain 2·1 p.ct. of benzol, 0·5 p.ct. of toluol, and 0·26 p.ct. of solvent naphtha. Its saturation limits are given in Table IV.

If the above percentages are subtracted from their respective saturation percentages, values are obtained showing the relative rates of absorption by the creosote for the washable products in the incoming gas. They are given in Table V.

TABLE V.—*Relative Percentage Rates of Absorption from above Gas of Washable Products by Creosote—Using 100 Gallons Per Ton.*

Temp.	15° C.	20° C.	25° C.	30° C.	35° C.	40° C.
Benzol, p.ct.	7·7	5·74	4·1	2·9	1·9	1·1
Toluol, p.ct.	7·77	5·0	3·6	2·7	1·96	1·43
Solvent naphtha, p.ct.	12·94	8·54	6·34	4·14	2·84	2·04

Washing with 50 gallons per ton, the following set of figures were obtained. Assuming complete extraction was effected, the creosote meeting unwashed gas contains: Benzol, 4 p.ct.; toluol, 0·96 p.c.; solvent naphtha, 0·51 p.ct.

TABLE VI.—*Relative Percentage Rates of Absorption from above Gas of Washable Products by Creosote—Using 50 Gallons Per Ton.*

Temp.	15° C.	20° C.	25° C.	30° C.	35° C.	40° C.
Benzol, p.ct.	5·8	3·84	2·2	1·0	0·0	0·0
Toluol, p.ct.	7·31	4·54	3·14	2·24	1·50	0·97
Solvent naphtha, p.ct.	12·79	8·29	6 09	3·89	2·59	1·79

Thus, it is seen that the rate of absorption of benzene drops much more quickly with increase of its concentration in creosote than does that of toluol or solvent naphtha. This means that the benzene and toluene disappear from the gas at the same rate when using 100 gallons per ton for the gas in question; but with 50 gallons per ton, the toluol disappears quicker than the benzene, indicating that reduction of the wash-oil used per ton is more likely to leave some benzene in the gas than toluene or solvent naphtha. The effect of temperature on the rate of solution when using 100 gallons per ton is seen from the line curves, and when using 50 gallons per ton from the dotted line curves (fig. 2). Thus

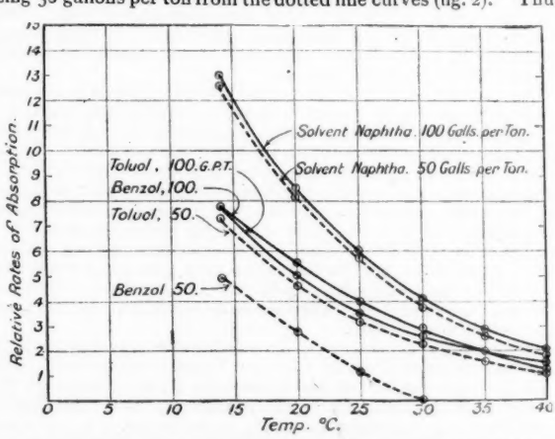


Fig. 2.—Relative Percentage Rates of Absorption of Washable Products by Creosote.

for benzene using 100 gallons of wash-oil per ton, the relative rate at 20° is 25 p.ct. less than at 15°, and at 25° is 46 p.ct. less than at 15°. This indicates that if the washer were only just stripping all the benzene from the gas at 15° C. it would leave 25 p.ct. in the gas at 20° C. In practice, washers are usually large enough to

practically strip the gas at 15° C. long before it leaves the washer, which allows a margin for increase in temperature.

It will be seen also that temperature affects the benzene and toluene about equally; but the rate for solvent naphtha falls rather more quickly. Using 50 gallons per ton, the percentage fall with rise in temperature for toluol and solvent naphtha is about as before—*i.e.* using 100 gallons per ton, but for benzene considerably higher—*e.g.*, at 20° it is 41 p.ct. less than at 15°, and at 25° it is 75 p.ct. less than at 15°. Hence, to a limited extent, the effect of temperature can be counteracted by an increase of wash-oil used per ton.

It may be necessary to remark that all the above relationships will be altered when gas of different composition is used; but similar calculations for any known gas are quite straightforward. The principle used in gas-washing is to bring the gas into intimate contact with a wash-oil which has a lower vapour pressure for the washable product than the partial pressure of the product in the gas at that stage in the washing process. Only under such conditions will the oil extract any of the product from the gas. The usual method is by the contra-current type of washer.

Intimacy of contact between the wash-oil and the gas is most important. Imagine one of the gas spaces in a washer, 1 inch cube, bounded on its four vertical sides by creosote surfaces. The molecules of washable products at and near the vertical central axis of the space have two principal motions—one bodily up, due to gas flow, and one laterally, due to interdiffusity. For any particular type of washer to give good efficiency per unit volume of washer, the rate of gas flow through the washer is limited by this last quantity, because if the gas is flowing too fast the molecules of washable products in the middle have not time to diffuse to the creosote surface. Consequently, the creosote at this point is prevented from absorbing as much from the gas as it otherwise would do. This loss of efficiency, involving "time of contact," can be remedied in two ways: (1) Reduce the size of the gas spaces in the washer—*i.e.*, obtain more intimate contact between the wash-oil and the gas so that interdiffusity plays a minor part in the process. (2) Give the gas a longer period in the washer. For a given quantity of gas, the latter can only be done by making the washer very large, as has been done in most types of washer—a serious consideration from the point of view of space and cost. The former can best be done by using wash-oil in the form of a spray, or even atomize it. Either way an enormous surface can be presented to the gas per unit volume of washer, and one that offers a minimum back-pressure to the gas.

If the efficiencies of washers be compared by the quantity of gas washed per volume of washer in a given time, the best results can only be obtained by developments along the spray washer lines. The same argument appears to hold when cost is considered. Another advantage of the spraying method is that the washing surface per unit of wash-oil is very much greater than with other types.

Quality of Creosotes used as Wash-Oils.

Quite apart from the quantity, temperature of the wash-oil, and method of washing, the physical properties and composition of the wash-oil play a vital part in the crude benzol extraction. The general specification for creosote used on benzol plants states, for the distillation: No distillate below 200° C., 80 to 90 p.ct. between 200° and 300°, and as little naphthalene as possible. Unless the conditions of distillation are always the same, the distillation is a very uncertain criterion—*e.g.*, two creosotes A and B, distilled under different conditions, gave:

Table VII.

	400 c.c. in Wurtz Flask.		4545 c.c. in a 3 gallon Still.	
	A	B	A	B
	p.ct.	p.ct.	p.ct.	p.ct.
0—200	1	0·7	5·0	—
200—220	7·5	2·0	9·1	1·4
220—250	47	17·6	28·1	15·0
250—300	28·5	44·6	24·5	31·1
Residue	16	35·2	33·3	49·5

A creosote used on benzol recovery plants has to meet several requirements; and as these requirements do not all demand the same physical conditions of the creosote, it is necessary to use a compromise specification so as to approximately meet all the conditions:

(1) The creosote, when steam distilled, must not fractionate and give off any large proportion of light oils.
(2) It must take up heat quickly and also cool quickly.
(3) It must flow or spray readily at the washing temperature—say 15° C.
(4) It must not emulsify if water gets into it.
(5) It must not give up naphthalene to the gas.

If the creosote contains light boiling oils, these, being more volatile in steam than the higher boiling oils, will distil out. Consequently, the crude benzol from a creosote containing a large percentage of light oils will be more contaminated with creosote distillate than one containing a low percentage. Moreover, if such light oils distil in the region of solvent naphtha, the washing power of the creosote for this body will be reduced.

Steam Distillation.

A word about steam distillation may not be out of place here. The various compounds in the creosote, as well as the products washed from the coal gas, have definite vapour pressures at (say) 130° C., according to the quantities present. Consequently, the steam becomes saturated with these vapours as it passes through the still. As the mixture of vapours and steam proceeds up the still, it expands till its pressure is atmospheric, and cools to, rather less than 100° C., and so some of the vapours condense, particularly the higher boiling ones. These are then made to exert a washing action on the rising vapours, and help to take out a further amount of high boiling bodies. Consequently the lighter vapours gradually increase in percentage in the steam; and when the mixture passes to the condenser, very little creosote should be mixed with the distillate—hence the advantage of the creosote not containing light oils.

Property of Fluidity and Viscosity.

Unfortunately, the lighter boiling portions of the creosote give it the property of fluidity, as will be seen later; and on this property depends the rapidity of picking-up heat in the distillation unit, and the rapidity of cooling of the debenzolized creosote in the coolers. The fluidity of the creosote at the temperature of washing also influences its efficiency in the washers. If it is not very fluid, it will not flow readily and give thin films, and it will not form such fine sprays in spray-washers.

Viscosity, the opposite of fluidity, is due to the force of attraction between the molecules of the substance. Consequently, as the temperature of a substance is raised and the effect of this attraction reduced, the viscosity falls, or the fluidity increases with rise of temperature. A large number of viscosity measurements have been made by the writer on different creosotes and their distillation fractions. The viscometer employed was the standard Redwood viscometer; and all the results are compared with the viscosity of rape oil taken as 100 units. The viscosity of water at 15° C. on this scale is 5·21.

The results for two creosotes supplied for benzol washing are quoted—one, a coal-tar creosote, which is called "A," and the other, a washed blast-furnace creosote called "B." The usual examination for these creosotes gave the following results:

Table VIII.

Creosote.	"A."	"B."
Sp. Gr.	1·0275	0·964
H_2O	0·25 p.ct.	0·2 p.ct.
First Spot	104° C.	135° C.
15–200 C.	1 p.ct.	0·7 p.ct.
200–220	7·5 ,,	2·0 ,,
220–250	47 ,,	17·6 ,,
250–300	28·5 ,,	44·6 ,,
Residue	16 ,,	35·2

The distillation was performed in a 700 cc. Wurtz flask, using 400 cc. creosote and distilling at two drops per second with the thermometer in the vapour.

The viscosities of these creosotes were determined for a range of temperatures up to 40° C., and the results were plotted to give the curves in fig. 3. The viscosity in both cases increases as the

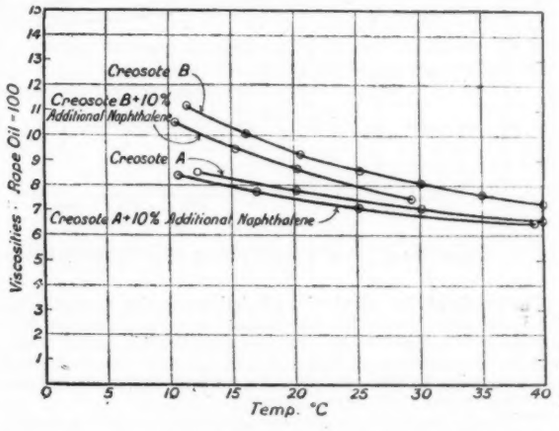


Fig. 3.—Viscosities of Creosotes A and B and with 10 p.ct. of $C_{10}H_8$.

temperature falls; but the increase is much quicker for B than A—presumably because B contains more high boiling substances than A. [See distillations above.] Besides reducing the cooling effect of the coolers on the plant, this decrease in viscosity militates against efficiency in the washer. Therefore, one sees that it is necessary to have a creosote which remains very fluid at temperatures between 10° and 20° C.

The results of viscosity tests done on the fractions of the creosotes are given as curves in fig. 4. The fractions were obtained by distilling a gallon of each creosote in an iron still. These curves show that the higher the boiling point of the fraction the greater the viscosity, also that the viscosity increases with fall of temperature more rapidly for these fractions than for the lower ones. The very high viscosity of the residue above 300° C. is significant, and is partly due to the constituents being solids, and having no oil to hold them in solution, and partly due to an indefinite amount of "cracking" or decomposition of the

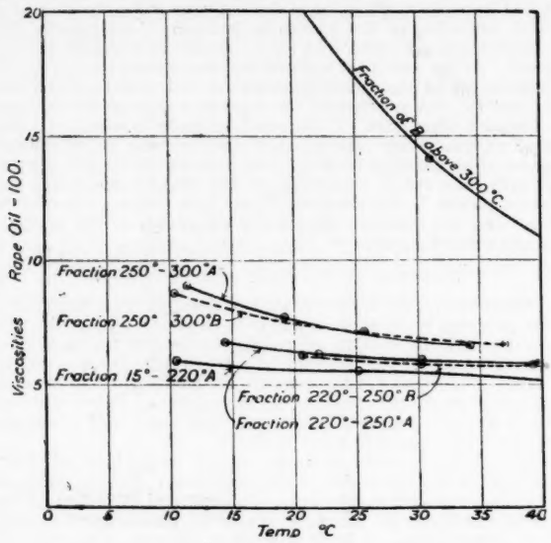

Fraction of B above 300 °C.
Fraction 250°- 300° A
Fraction 250° 300° B
Fraction 15°- 220° A
Fraction 220°- 250° B
Fraction 220°- 250° A
Viscosities Rape Oil = 100.
Temp °C

Fig. 4.—Viscosities of Fractions of Creosotes A and B.

bodies, at the high temperature of distillation, into lower boiling oils and solids.

Creosotes A and B were then subjected to steam distillation at 130° C., and viscosity determinations were made on the residues, after different quantities of oils had been distilled-out. These results are given as curves in fig. 5, and indicate the serious increase in the viscosity caused by taking out the lighter fractions.

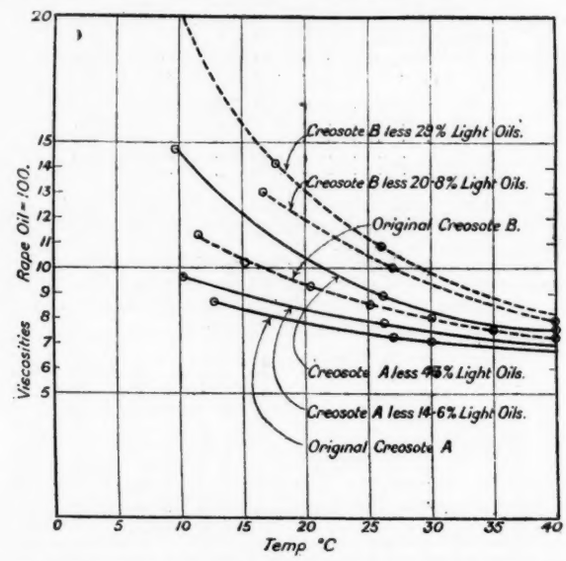

Creosote B less 28% Light Oils.
Creosote B less 20·8% Light Oils.
Original Creosote B.
Creosote A less 4·5% Light Oils.
Creosote A less 14·6% Light Oils.
Original Creosote A
Viscosities Rape Oil = 100.
Temp °C

Fig. 5.—Viscosities of A and B and Residues after Steam Distillation.

The study of the effect of naphthalene on the viscosity led to the interesting result that the extraction of naphthalene leaves the creosote more viscous. To take naphthalene out of creosote without also taking any oil is difficult; but the above conclusion was borne out by adding 10 p.ct. to each of the creosotes A and B. The results are given as curves in fig. 3.

To determine as to whether creosotes thicken due to continual heating in the plant, creosote A was heated for several days by direct gas flame and kept at 130° to 160° C.; but no appreciable increase in viscosity was noticeable. Consequently, it is fairly reasonable to conclude that the heating has in itself little effect on thickening. The highest temperature to which creosote can be subjected on plants using steam heating (100 to 110 lbs. pressure) is 173° C. If the creosote is washing a purified gas, it cannot thicken by washing-out tar; hence the cause of thickening after prolonged use is the taking-out of the naphthalene and the lower boiling oils with the crude benzol. When these light oils are added to the creosote again, it assumes its original fluidity, apart from that due to the loss of naphthalene. Naphthalene is objectionable chiefly because it may, under certain conditions mentioned later, go into the gas.

The writer's attention was first drawn to the importance of viscosity by noticing that, when new creosote was added to replace spent creosote, higher temperatures were obtainable in the oil entering the still and lower temperatures in the oil leaving the coolers and going to the washers. The effect of viscosity on relative rates of cooling of creosotes of different viscosities has been briefly studied in the laboratory by the method given in the appendix. The times taken to cool, under similar experimental conditions, from 120° to 15° C. were observed, and the results plotted as curves in fig. 6. The rate of cooling for any given conditions

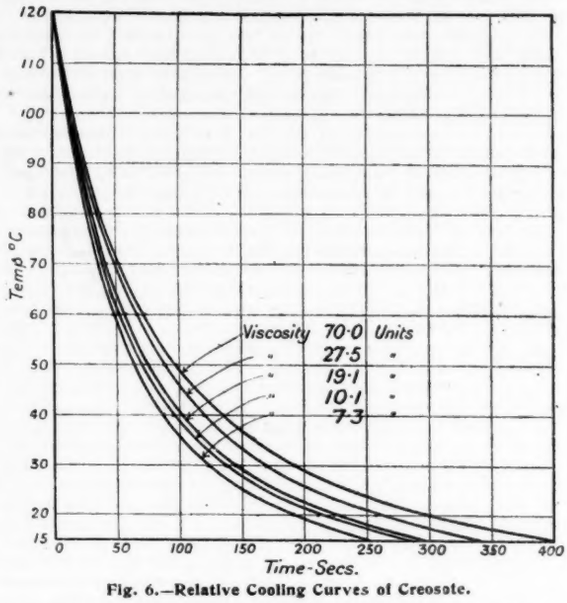


Fig. 6.—Relative Cooling Curves of Creosote.

and system of coolers depends on the viscosity and specific heat of the oil; but as the latter will not vary greatly from one creosote to another, viscosity plays the chief *rôle*. The heat in a liquid flows from one part to another by convection currents; and viscosity acts as a drag on these currents. Heated to 120° C. the creosotes tested cooled to the following temperatures in four minutes:

TABLE XII.

Temperature Attained.		Specific Gravity at 15° C.		Viscosity at 15° C.
16·0°	..	1·041	..	7·3
17·5	..	0·964	..	10·1
21·5	..	1·020	..	27·5
24·0	..	1·082	..	70·0

These results are given in fig. 7. It is clearly seen that the influence of viscosity is greater the lower the temperature to which it

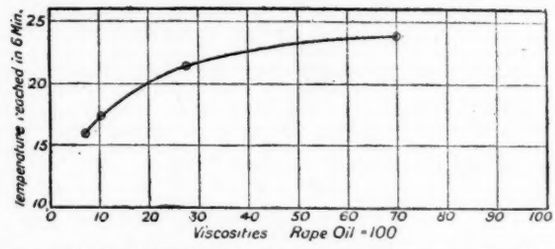


Fig. 7.—Effect of Viscosity on the Amount of Cooling in a Given Time.

is desired to cool the creosote in a given time. It is worthy of notice here that, when using mixtures of coal gas and blast-furnace creosotes, specific gravity is no criterion as to whether a creosote is spent. The viscosity test is the best one to adopt.

EFFECT ON THE NAPHTHALENE CONTENT OF COAL-GAS DUE TO CREOSOTE WASHING.

Assuming that a given percentage of naphthalene in a creosote washed free from tar acids has a vapour pressure for naphthalene equivalent to that percentage of the vapour pressure of pure naphthalene at the given temperature; then such creosotes will have the vapour pressures expressed as curves in fig. 8.

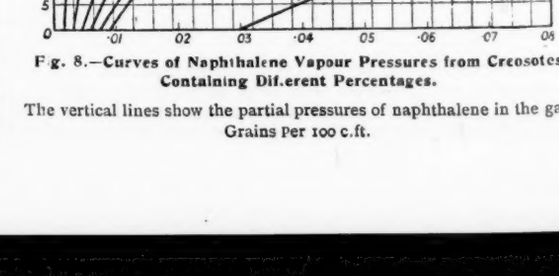


Fig. 8.—Curves of Naphthalene Vapour Pressures from Creosotes Containing Different Percentages.

The vertical lines show the partial pressures of naphthalene in the gas. Grains per 100 c.ft.

The partial pressure of naphthalene in coal-gas is as follows: Multiply grains per 100 c.ft. by 0·0032; 1 grain per 100 c.ft. exerts a partial pressure of 0·0032 m.m. of mercury. The pressures of naphthalene for each additional grain from 1 to 16 are given prominence in fig. 8 by the black vertical lines.

It is a simple matter now to see whether washing at a given temperature a gas of known naphthalene content with creosote containing a known amount of naphthalene will either take naphthalene out of the gas or put naphthalene into it—*e.g.*, for a gas containing 5 grains per 100 c.ft., washed with a creosote containing 15 p.ct. of naphthalene, the creosote must be kept well below 25° C. if the gas is not to pick-up naphthalene. The pure naphthalene curve shows at what temperature gas containing naphthalene would deposit it due to cooling alone.

Naphthalene deposition on the district appears to be due to two causes: (1) The deposition due to cooling a gas rich in naphthalene; and (2) due to pipe friction or influence of a large scrubbing surface—on gas unsaturated with respect to naphthalene—a factor of uncertain magnitude. The trouble is intensified when the usual solvents are washed-out, because the naphthalene is not washed away to the syphons.

The above curves of vapour pressures of naphthalene in creosote may not represent absolute fact, but are given as being indicative of what happens in practice.

Conclusions.

(1) The efficiency of washing is greatly improved by using a cold oil—say, 15° C.—providing the creosote keeps sufficiently fluid.

(2) The lighter oils in creosote—180° to 220°—help the washing process by lessening the viscosity of the creosote, but are objectionable in that they are readily distilled-out by steam and contaminate the crude benzol.

(3) Naphthalene helps to lessen the viscosity, and thereby helps the washing, but is very objectionable, in that it prevents good extraction of naphthalene from the gas, and may even add some to the gas under certain conditions of quantity and temperature.

(4) Creosote fractions boiling above 300° greatly increase the viscosity, and are very objectionable if present to any extent.

(5) A good creosote should remain as fluid as possible at 10° to 15°; give little oil distillate when steam distilled; and have as low a naphthalene content as possible.

(6) Much improved cooling of debenzolized oil from the crude still is obtained by using a creosote of which the viscosity rises very little when cooled to 10° to 15°, and better temperatures are obtained for benzolized oil entering the crude still.

(7) The efficiency of washing is greatly improved by increasing the intimacy of contact between the oil and gas. Washers on the spraying or atomizing principle appear to offer the best field for development in this direction—namely, an increase of surface per volume of washer and a minimum back-pressure.

(8) When using mixtures of blast-furnace and coal-tar creosotes specific gravity is no criterion as to whether a creosote is "spent" or not. Viscosity is the best test, and its magnitude should be between 8 to 9, with a maximum of 10 (rape oil = 100).

(9) A sufficient quantity of creosote should be in circulation to prevent the light oils taken out and contained in the crude benzol in stock leaving a creosote of high viscosity. If light oils are sold with crude benzol, then either the creosote must be changed more frequently or the equivalent quantity of similar light oils added to take the place of those in the crude benzol.

Appendix.

The vapour pressures of washable products from coal gas and of benzolized and debenzolized creosotes were carried out in the apparatus shown in fig. 9. Liquids exert the same vapour pressure in air as in a vacuum, and, consequently, on introducing a liquid into a known volume of pure air the pressure increases through two causes: (1) The fact that the liquid takes up room. (2) The vapour pressure of the liquid.

By calculating No. 1, and subtracting it from the observed pressure, the vapour pressure of the liquid at that temperature is obtained, Time must be allowed for the vapour to fill the whole of A. On raising the temperature of the glass bulb A (by water in the water-jacket), and preventing expansion of the contents by raising the mercury reservoir until the mercury always reaches the mark B, the pressure again increases through two causes: (1) Increase of pressure of air due to heat and space occupied by liquid. (2) Increase of vapour pressure. No. 1 can be calculated, and, when taken from the observed pressure, leaves the vapour pressure at that temperature. By using redistilled liquids the effect of dissolved gases is greatly eliminated. The method gave correct results for benzene when compared with results of more elaborate apparatus.

The relative rates of cooling of creosotes were determined as follows: 40 c.c. of creosote were placed in A (Fig. 10, a 50 c.c. Jena bulb) with the thermometer immersed in the centre of the liquid, always to the same extent. Water at a constant temperature was circulated through the water bath at a constant rate, sufficient to prevent the temperature on the outside of A rising more than 1° C., as indicated by the thermometer in the water. A was heated to a uniform temperature of 120° C., then plunged into the water-bath (always in the same position in the bath), and the rate of fall of temperature was recorded in seconds—using a stop watch. The experiment was stopped when the creosote reached 15° C.

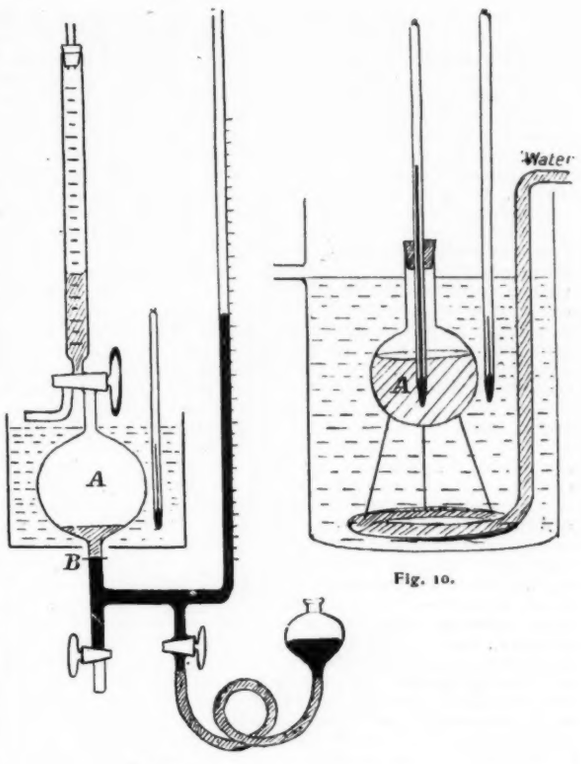


Fig. 10.

Fig. 9.

DISCUSSION.

The President (Mr. G. C. Pearson, of Windsor Street), after acknowledging the kindness of those in authority in placing at the disposal of the Association the reading-room at the Council House, where the meeting was held, asked Mr. B. W. Smith to propose a vote of thanks to the author of the paper.

Mr. B. W. Smith (Walsall) said he felt the President conferred an honour upon him, by asking him to propose a vote of thanks to Mr. Rhead for the excellent paper he had just given them. It was to be feared that the extremely technical nature of his contribution rather debarred them from discussing it at first sight. It was a paper that needed study. Personally, he felt he was unable to say much upon the subject, except that it was a paper of great value to all those who were working on benzol plants. He, for one, had not yet had an opportunity of putting one of these plants to work. He had, however, studied the question very carefully, and hoped by the end of February, if the contractors would deliver it, to have his plant in operation. He had visited the plant at Nechells, and had had everything there explained to him. There was one interesting point in the paper which he would like to mention. Recently he came across what appeared to him to be a rather strange phenomenon. Like many others, he might say, he had been using creosote oil for the elimination of naphthalene. This he had employed in one of Holmes's rotary brush washers; and now, for the first time, after something like fifteen years, he had met with ammonium carbonate being formed in this washer. It was a very strange thing; and he felt so uncertain about it at the time, that he communicated with the firm who supplied the creosote. He made his own tests in the laboratory, and asked the firm to confirm what he had found. They said that it was ammonium carbonate, and one or two other chemicals, which had come together in a solid form, making a skin on the inside of the washer, and coming out as a yellow paste. They said it was due entirely to the temperature. Since he had put steam underneath—which he had never had occasion to do before—it had seemed to pass away. During his many years' experience as a gas engineer, he had never hitherto come across anything of this nature.

Mr. E. W. Smith (Chief Chemist to the Birmingham Corporation Gas Department), in rising to second the vote of thanks, wished, before dealing with points raised by the paper, to say that the war had required the members of the gas industry to apply themselves to many problems—toluol extraction was one of them—to which previously they had paid little attention; and he, for one, had been glad of the opportunity of doing so. He was sure Mr. W. A. Twine (the Chemical Plant Superintendent) would agree with him when he said that they had learned much in their experience with the toluol plant at Nechells which would

prove of use to them in their work for the department in the future. As to the point just raised by Mr. B. W. Smith, he knew that other people had experienced the same difficulty, particularly in creosote washing for naphthalene. As regarded Mr. Rhead's paper, one had only to follow the accounts of the difficulties experienced by those operating gas-washing processes for crude benzol, to be impressed with the extent to which the recognized theories of gases and vapours were neglected or overlooked. One was specially struck by recent accounts of coke-oven practice. Really, one had the feeling that chemists in gas-works had generally got down to things a great deal quicker than coke-oven practice had without the chemists—he meant, of course, well-trained technical chemists. This was all indicative of the fact that all chemical processes ought to be controlled entirely by highly-trained chemists. Mr. Rhead had served a very useful purpose in calling their attention to the bearing of some of these theories in relation to gas washing. One of the chief difficulties in all gas-washing processes was the question of wash-oil. Generally speaking, there were three types in use—gas creosote, blast-furnace creosote with gravity less than 1, and green oil. Green oil, he thought, was only gradually coming to be used to any extent at the present time. Now, Mr. Rhead had brought out strongly—and it was a very important matter—the question of viscosity. He had laid it down that viscosity was the test to follow, in preference to gravity. There was no question whatever about this. It was not possible for anyone using a toluol plant to get the average composition of the creosote when mixtures were used; and consequently gravity was nothing whatever to go by. The author agreed, he believed, that, subject to there being a satisfactory distillation of the creosote, there was a satisfactory viscosity. If the distillation was right, the viscosity must be right. The specification to which they were endeavouring to work in Birmingham, was one in which there was as little distillate below 220° C. as possible, and as little above 300° C. as possible—10 p.ct. being the maximum. This was due to the fact that, if one took out the lighter fractions, then the viscosity of the residual oil would be satisfactory; while if one had much above 300°, there would be high viscosity of the residual oil. Just after the war started, the Nechells plant used gas oil. At the present time, gas oil was extraordinarily dear; but he thought it was highly probable that it would be still worth while to use it. Where the losses of wash-oil during working were high, it certainly would not pay to use gas oil; but where the losses were kept reasonably low, the results to be obtained by employing gas oil, might easily justify doing so. The chief objection was that gas oil was a paraffin, and contaminated the benzol and toluol with paraffin hydrocarbons. He understood in the case of toluol that this did not matter; but that with benzol it was very important that paraffin should be kept out, as it was a constituent which interfered with the production of high explosives from benzol. They might, however, consider that gas oil had a distillation of never more than 1 or 2 p.ct. below 200° C.; and during steam distillation, they were not likely to get any considerable quantity of paraffins in the benzol or toluol. What determinations he had had made indicated that there was no more paraffin in the benzol from gas-oil washing than when washing with creosote. If it was a fact that the paraffins little affected the benzol, then, owing to the suitable viscosity of gas oil, it would appear that this would be better for cooling and heating than any other wash oils they had tried. Anglo-American gas oil as it was delivered had a viscosity of 8·2 at 15·5° C. The fraction between 200° and 220° had a viscosity of 4·9, compared with 6 for the same fraction of creosote. Between 220° and 250°, the figure was 5·3, compared with 7 for creosote; between 250° and 300°, 6·7, compared with 7·5; above 300°, 17·2, compared with something well over 30 for creosote. So it would appear that, if one distilled off the lighter fractions of the gas oil, the residual oil would have a satisfactory viscosity. He had known of benzol plants—their own particularly—that had used such oils for a considerable period; and there seemed to be no deterioration of the gas oil as compared with creosote for the same period. This was a matter into which they were going a great deal further, and on which they would have to come to a decision in the near future. Then Mr. Rhead mentioned the question of an atomizer washer. He had no doubt whatever that the author was on the right lines, when one considered that, in the extraction of naphthalene, it was strongly recommended that they should use an atomizer in the mains for atomizing the solvent, and that very good results were obtained in this way. With cyanide extraction, one used a water atomizer to dissolve out the ammonia and cyanide in the production of ammonium sulphocyanide. Further, it was not at all difficult to obtain 90 p.ct. efficiency at the condensers for ammonia; the equivalent of a spray being obtained by mere condensation of the water vapour in the gas. He was going to try in the course of a few days the effect of adding steam at the inlet of the condensers, and endeavouring to cool the gas to normal temperatures, in order that an excessive cloud should be brought about in the condensers to take up ammonia. By this means he had no doubt the condensers would be increased in efficiency. Under the present method of determining the washable products in the gas, those engaged in running toluol plants objected that they were operating a plant they could not test. They did not know whether the efficiency was 90 p.ct. or 80 p.ct.; and they complained because there was not a satisfactory method propounded for determining the amount of crude benzol in the gas. It was almost impossible to maintain the gas rate in the test. As the test extended over about a week, it was impracticable to have it supervised over the whole of this period; and runaways inevitably occurred, and washable products escaped. They had found it possible at Nechells the last few days to devise means of controlling this rate; and he thought they would therefore get better results. In fact, it ought to be possible to secure very much better results now that the rate could be controlled and kept below 1 c.ft. per hour, and the temperature of the wash-oil also kept down. He was very glad to have the opportunity of expressing his thanks to Mr. Rhead for the very large amount of work he had put into his paper. He had filled a great want in drawing attention to the theoretical study of gas washing. It had been too much a rule-of-thumb in the past; and all such papers as this would add to the efficiency of the process.

The PRESIDENT remarked that it was very difficult for those of them who had not seen the paper before the meeting to really grasp the subject thoroughly at once, so as to be able profitably to discuss it. The thing that struck him, however, was the simple manner in which Mr. Rhead had put forward these higher chemical problems. When they had had an opportunity of digesting the paper, they would certainly all derive great benefit. Undoubtedly, the considerations submitted in the paper applied not only to benzol recovery, but to many other processes in gas manufacture. He had been interested in what was said about atomizing for gas washing. He took it the author meant really atomizing, and not spraying, because he thought that most of the makers of washers were adopting the spray type. It seemed to him it had to be proved that the horizontal type was not the better of the two. As to the effect that actual atomizing would have, he could not say anything; but to his mind it was not yet proved that the horizontal washer with brushes or bundles was not as good a type as spraying water. Mr. E. W. Smith had made some interesting remarks on the subject of condensation; and no doubt a great deal could be done in this direction. They would be glad later on to hear the results of his experience. He (the President) wondered whether the latent heat of the steam might not come too much into play. With regard to Table VII., he noticed Mr. Rhead had distilled two different quantities—400 c.c. in one case, and 4545 c.c. in the other. He would like to know whether the rate of distillation had been altered, or was the same in both instances. As to fractions above 300° greatly increasing the viscosity, he took it this figure was altogether higher than one got in actual practice—that it was merely a laboratory experiment to show the effect of high viscosity.

Mr. RHEAD, in his reply, suggested that a possible explanation of the matter mentioned by Mr. B. W. Smith was this: As it was well known that CO_2 and ammonia dissolved fairly readily in creosote, it was probable that they had combined more readily in the creosote than in the gas, and subsequently crystallized out. The President had raised the question of spray washing as against horizontal washing. Probably, comparing the present-day spray washer with the horizontal washer, the latter had the advantage. With a horizontal washer, it would be almost impossible to increase its efficiency any further; it took out practically all that was required of it. But suppose one wanted to erect a washer taking up less space or less expensive, the only thing to do would be to adopt an improved form of spray washer or an atomizing one—he did not know which really would be best. As to the query about the rate of distillation, this was as far as possible the same in both cases. He really thought it was a question of better fractionation in the bigger still. With regard to the viscosity of the fraction above 300°, of course one did not get this temperature on steam-heated plants. The reason it was brought in was that creosotes were at present generally bought on this distillation. He gave the figures to show how the fraction above 300° really affected the creosote.

Mr. E. W. SMITH: I think Mr. Pearson's point is really that the figure for viscosity of the creosote fraction above 300° does not represent the viscosity of that fraction when present in the main bulk of creosote, but is only the viscosity of the fraction after having been cracked on a small-scale test.

Mr. RHEAD: I make the point in the paper that the high viscosity may be due to a certain extent to the cracking.

Comparative Costs of Light per 1000 Candle-Hours.

The United States Bureau of Standards has issued a statement of the average cost of light from various sources, including the cost of maintenance, if such is required, that may be accepted as independent evidence as to the relative economy of modern gas lighting. The figures are as follows:

Candles	$2·00
Kerosene, flame	0·19
,, mantle	0·06
Gas, open flame	0·24
,, mantle	0·06
Electricity, carbon filament	0·35
,, gem	0·26
,, tungsten	0·13

Arrangements have been made for members of the Manchester and District Junior Gas Association to visit next Saturday the Oldham Corporation Gas-Works, on the invitation of Mr. T. Duxbury, the Chief Engineer. After tea, as the guests of the Gas Committee, Mr. F. F. Mooney, of the Rochdale Road Gas-Works, Manchester, will read a paper on "Coal Tar Analysis."

SCOTTISH JUNIOR GAS ASSOCIATION.

(WESTERN DISTRICT.)

Lecture by Professor Henderson.

The Scottish Junior Gas Association (Western District) met in the Royal Technical College, Glasgow, last Saturday week—Mr. GEO. T. PURVES (the President) presiding.

The evening was devoted to a lecture by Professor G. G. Henderson, who, in explaining the reason for the cursory nature of his address, said that, like so many others, he had been very actively engaged on war work for a considerable time. Moreover, all his staff had been so eager to join the fighting services that he had found it very difficult to carry on the department, apart altogether from outside work. Members of the Association must, he said, be directly and personally interested in those industries which used coal as their raw material. It was unfortunate from many points of view that so very few people seemed to realize that coal was one of the most important material assets of this country. It was deplorable that they found coal being wasted in a perfectly heart-breaking way. The ordinary consumer utilized coal for the production of heat, and wasted not only the energy of the coal, but also all those materials that could be obtained by the rational use of it. Whenever coal was consumed under ordinary conditions, in a domestic fire or a furnace, they had to face the fact that they lost a great proportion of the total energy contained in it, and they also threw away those materials they could get from coal in addition, which were the starting point of industries of great importance. It was precisely these materials which were the starting point for the manufacture of synthetic drugs, perfumes, a large number of materials used in photography, and a great many organic chemicals in general. These were thrown away when coal was burned in an open fireplace or furnace.

COAL WASTE AND USE.

He was told there was wastage in the winning of coal; there was also wastage in dragging it about the country and in exporting it. There might be very strong arguments in favour of the export of coal, but was any one of them stronger than this—that for every ton of coal exported from this country the industrial life of the country was shortened by an appreciable period. If they exported many millions of tons of coals, by how much did they shorten the country's industrial life? This was a point that was worth deep consideration. They were the men interested in one of the rational methods of using coal—the carbonization of coal with the main object of preparing coal gas. They had also the carbonization of coal in coke-ovens with the main object of obtaining coke. These were rational methods, because, while they could utilize the energy of the coal, they could get bye-products in addition to the gas and the coke—nitrogen compounds, tar, and other materials of extreme value. This rational treatment of coal, especially with regard to the coal gas industry, was one which had been in operation for a considerable period—more than 120 years. It was really amazing to find what an enormous amount of coal was utilized in the production of gas; and it was also amazing to find with what rapidity carbonization of coal with the object of producing coal gas had extended.

THE GAS INDUSTRY A CHEMICAL ONE.

The treatment of coal was, of course, one of the largest and one of the most important of the chemical industries of the country. Consequently, it was almost a truism to say that the direction of this industry should be in the hands of highly-trained technologists. Indeed, what he wished to press upon them, and through them upon others, was the necessity in this branch of industry of securing the best men in capacity and in training. There, of course, the chemist must work in co-operation with the engineer. He did not need to labour the point of the necessity of the thorough training of the coal technologist, because they had only to grasp the history of the industry to see this necessity forced upon them at every point. It had been in his mind, and in the minds of many others, for a long time that it was not sufficiently realized that the gas industry was a chemical industry. Let them just look at the changes in the methods of carbonizing coal, the changes in the character of the gas products. When coal was first distilled, and for many years after, the main use of coal gas was as an illuminant. With the introduction of the incandescent mantle, however, the necessity for the production of a luminous gas became much less marked. The main aim of the technologists must now be to produce a gas of the maximum heating power; luminosity being comparatively unimportant.

EVOLUTION OF THE GAS-RETORT.

If one looked at the development of the apparatus used for distilling coal, one saw that the retorts almost unconsciously had been modified in such a way as to produce gas of the small luminosity wanted. They knew, of course, that if they carbonized coal at what was a comparatively low temperature—below 450° or at the outside 500°—they got a mixture of gas and oil distillate. If they took the residue and heated it up to a higher temperature, a large quantity of gas was still evolved. If they took a low-temperature distillate and heated it to 900°, they found the higher paraffins beginning to break-down into simpler ones; and if the gas was kept in contact with the heated surfaces for any length of time, the changes were more pronounced. When they carbonized coal, the composition of the gas and tar obtained depended upon several factors. They depended not only on the composition of the coal, but also upon the presence or absence of water; they depended upon the time and temperature of heating, and upon the duration of the contact between the heated material and the heated walls of the retort. This was seen if they regarded the composition of the gas and tar obtained in different types of retort. They started with a period of small horizontal retorts partially filled with coal, and then more completely filled. Then they reached the period of inclined retorts. The tendency of later years had been to keep the retorts full. Then there came the idea from the shale industry of using vertical retorts. This development in regard to the retort had mainly been a development from the point of view of the engineer. He wished to handle as large a quantity of material as possible, and handle it expeditiously and economically, while at the same time getting coal gas along with other products. He (Prof. Henderson) thought that the change in the chemical reactions brought about had been lost sight of. As it happened, however, the modern type of retort gave them a gas which was very well suited for modern purposes. But he did not think this had been derived from scientific organization. The gas they obtained from the retort was very far from being pure. Indeed, it was a rather curious point about the coal gas industry. They started, like others, with a raw material; but their finished product was not a unified material. In most other industries the manufacturer aimed at getting his results in as pure a state as possible. The crude gas they obtained from the retorts must necessarily undergo purification, separation of the tar, water vapour, naphthalene, sulphur compounds, ammonia, hydrocyanic acid, &c. All of these involved to some extent physical and chemical methods of work. As to ammonia recovery, only a small percentage of the nitrogen in their coal was recovered with the ammonia. There was an appreciable percentage in the form of hydrocyanic acid, and a certain amount was set free, and a considerable quantity remained in the coal. Why should not their processes be modified in order to get a larger proportion from the coal? In ordinary circumstances, they obtained less than 20 p.ct. converted into ammonia; in the Mond process, they got 65 p.ct. This required investigation. Combined nitrogen was very valuable, and commanded large sums of money.

A GREAT REGION FOR THE ACTIVITIES OF THE CHEMIST.

With regard to the removal of sulphur compounds, they must not lose sight of the catalytic method. It was now in use at the South Metropolitan Gas-Works, where the heated gas was passed through a tube containing porous fire-clay impregnated with nickel. How strictly chemical the question of purification was! They found it further in the question of the utilization of bye-products. The cost of production was determined by the money they received from the bye-products. Under favourable conditions, he supposed that at least half the cost of the production of gas should be met. He hoped some day to see gas-works extend their bounds and attempt not only the distillation of tar, but the washing-off of the raw products obtained from the tar. There was a great region for the extension of the activities of the chemist in the gas-works. They must remember that scientific research was the soul of industrial prosperity, and consider the work that remained to be done. Take the naphthalene question. Were they still to be troubled with the purification of their gas from naphthalene; or could they not produce a gas free from it? He thought they could. As an example of research, he referred to the paper by their President, Mr. Purves, on the extraction of tar fog from hot gas. In it was a table giving the products of distillation of tar obtained from different types of gas-retorts with heavy and lighter charges. It showed how the composition of the tar varied with the kind of retort used.

THE CHEMIST NEEDED.

The domestic mind in many cases adhered to the use of solid fuel. This extravagance must be stopped. They must find a substitute. Ordinary coke was not a substitute from the domestic point of view. The way out was to discover a really satisfactory method—an economical method of producing smokeless fuel by low-temperature distillation. There was another problem before them, an allied problem worth looking into—the utilization of peat. Peat was a worthless substance commercially; but it was capable of being converted into a gaseous fuel. What he was leading up to was this—the necessity with such a vastly important industry as theirs of getting men as highly trained as possible. The nature of the training was dependent to some extent on the branch of the industry a man was going to follow. The gas-works chemist in the past had often been nothing more than a testing machine. There was, of course, a great deal of routine analyses that must be done; but it was a most uneconomical thing to utilize a highly-trained man for routine work which could be efficiently done by a skilled labourer. A gas-works chemist should not be a routine tester, but a source of ideas and methods by which the processes of the manufacture of gas should be determined and controlled. The gas industry was a chemical industry; and the processes followed in the gas industry should be under the control of a chemist. The chemist must be sufficiently in touch with engineering problems—the problems involved in the methods of handling the material—to prevent him making the mistake of proposing the introduction of processes which would be condemned by an engineer. The chemist in the gas industry

must be the most important factor; but almost equal in importance must be the engineer. There was the necessity for co-operation between these two scientific men. It would no doubt be desirable if they could combine the qualities in one individual; but his own experience led him to form the conclusion that it was only in exceptional cases that they would find a man with the qualities of mind that fitted him to be at once a skilled chemist and a skilled engineer. Quite broadly speaking, the mind of the engineer was more constructive and less analytical than that of the chemist. At the same time he (the lecturer) was satisfied that in training the chemist for the gas industry it was desirable to add to his chemical training such an amount of engineering training as would make him not an engineer but able to meet the engineer in his own grounds and fully understand him. This was perfectly possible. It was also a great misfortune that those engineers who were going to take part in the gas industry should not have more chemistry added to their training. If they required highly-trained men to carry forward the industry, what type of training must they have? Here they met with a certain amount of difference between the requirements of the engineer and the chemist. As they knew, the training of the ordinary engineer was carried out partly in the university or college, where he got theoretical instruction; but a large amount of his training was in the engineering shop.

In the case of the chemist, however, a very large part of his training—he cannot complete his training in any institution—must be spent in the laboratories of the college. This required time. Experimental subjects, such as chemistry and physics, one could not learn from books. They must learn them experimentally. The gas-works chemist must have a sound general knowledge of chemistry—a special knowledge of the chemistry of fuels in general, and coal in particular. He must, moreover—and this was very important—have a thorough knowledge of physics. A great many of his problems would be physical ones, or problems where physics and chemistry met. Take such a simple matter as the burning of carbon. They had a great deal yet to learn about this subject—whether they were going to get carbon dioxide, carbon monoxide, or both. Many physical matters came in such a course as he had outlined, and demanded four years of the students' full time. A sound system had been introduced for the training of the engineer—the sandwich system. He spent six months doing theoretical work and the next six months doing part of his apprenticeship. At the very start of his career, he got into touch with the strictly practical matter. This revealed a weak point in the training of the chemist. He would like to see a similar sandwich system introduced for him. Where a student had come into touch with practical problems, he showed a keener appreciation of the purely scientific bases on which the working-out of problems was made; he appreciated the importance of the theoretical instruction which he received. Many students, through force of circumstance, had, however, to earn their living during the day. They provided for this by evening classes. Some people were rather apt to be down on evening classes. So far as the Technical College was concerned, the evening students compared very favourably with the day students. They found many students who began with evening classes were, through the assistance given them, enabled to put in part of their work during the day.

The PRESIDENT, commenting on the address, referred to the question of low-temperature carbonization, which Prof. Henderson thought quite possible. It was so difficult practically that it was very unlikely that it would be realized. To make a coke hard enough, it must be treated at a high temperature. No housewife wants smoke away and dirt in its place.

A vote of thanks to Prof. Henderson concluded the proceedings.

American Sulphate of Ammonia Output.

The Barrett Company, of New York (according tothe "Chemical Trade Journal"), estimate that the American production of ammonium sulphate at coke and gas plants in 1916 was 325,000 tons. This shows an increase of 47·7 per cent. over the production of 220,000 tons in 1915. Bye-product coke-ovens produced 272,000 tons, or 83·7 per cent. of the total. It is probable that the full capacity of coke-ovens and gas-works will in 1918 reach 580,000 tons or more of ammonium sulphate—*i.e.*, about 120,000 tons of nitrogen. The demands of the industries, for nitrogen in both ammonia and nitrate of soda (excluding export products and fertilizers), do not exceed 70,000 tons of nitrogen per annum. For ammonia alone, they are not over 25,000 tons of nitrogen.

Stacking Soft Coal with Safety.—The Boston office of the National Fire Protection Association (who report a larger number of fires from spontaneous combustion than usual) remark that the storage of bituminous coal involves a distinct and unavoidable hazard. They suggest that the following safeguards be adopted: (1) Storage should be as far as possible from plant buildings, and never against frame buildings. (2) If space permits, piles should not exceed 12 ft. in height. (3) Wet coal should be piled around the edges of the storage, where air can get to it freely. (4) Pipes 3 or 2 in. in diameter should be inserted, with the lower ends at different levels. The pipes should preferably be perforated. One 3-in. pipe to 400 sq. ft. of surface is sufficient.

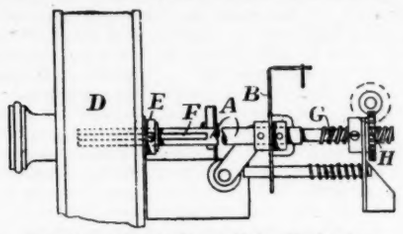
REGISTER OF PATENTS.

Coin-Freed Meters.

HUTCHINSON, B. G., of Barnsley.

No. 13 926; Oct. 1, 1915.

In this coin-freed gas-meter, a sliding screwed spindle A operates the supply valve by means of a bracket B, loosely mounted on the spindle between two fixed collars and working on a fixed guide-rod C. The spindle is rotated by a crown-wheel contained in the casing D, after the insertion of a coin; a screw passing through a collar E and a boss



Hutchinson's Coin-Freed Meter Mechanism.

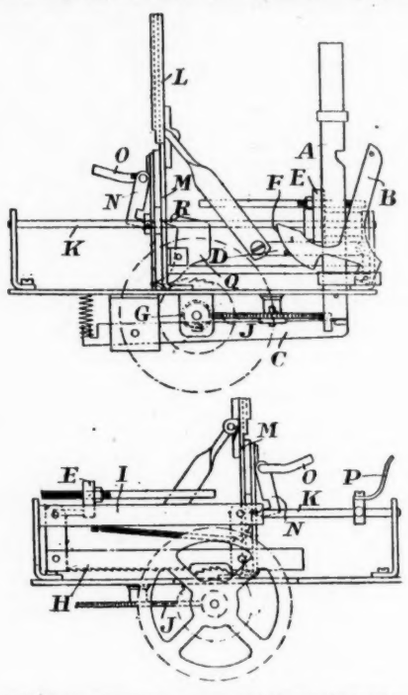
on the crown-wheel engaging a longitudinal slot F in the spindle. A threaded portion G of the spindle works through a hollow wheel-nut H, which is rotated by the meter mechanism. A spring on the guide-rod C serves to re-engage the threaded portion G with the nut H if disengagement of these parts takes place.

Coin-Freed Meter Apparatus.

WHITE, J., and CANOVA, V., of Birmingham.

No. 14,004; Oct. 2, 1915.

In this arrangement, a counterweighted supply valve (not shown) is held in the closed position by a sliding rod A, which is adapted to be locked in the upper position by levers B C controlled by the coin-carrier and quantity mechanism. A pin on the counterweighted lever B engages a notch in the slide A, except when the coin-carrier is in the normal position, as shown; while a pin on a link D connected to one part E of the carrier co-operates with a curved arm F of the lever. A projection on the spring-controlled lever C enters a notch in a disc G



White and Canova's Coin-Freed Meter Mechanism.

of the quantity mechanism when the prepaid quantity of gas has been consumed—the lever C simultaneously raising the slide A and closing the valve. The disc G is mounted on the spindle of a ratchet-wheel, which is rotated by a toothed bar H connected by links to the other part I of the coin-carrier. In order to allow a large number of coins to be inserted in succession, the lever C is provided with a second projection co-operating with a notch in a worm-wheel J driven by a worm on the spindle of the ratchet.

The two parts E I of the coin-carrier work on guide-rods K, and are adapted to be coupled together by a penny or two halfpennies; the part E being actuated through links from a handle L, which forms part of the coin shoot. A penny is supported on shoulders on a fixed plate M, disposed in front of a plate attached to the part I, in which position the coin is engaged by a pin on the part E, so that the two parts of the carrier move together. The projection of a counterweighted lever N moves through apertures in the plate to which it is pivoted to support the coin as it moves off the shoulders of the plate M. The pro-

jections are withdrawn to effect the discharge of the coin by the engagement of an arm O of the lever N with a fixed stop P. In the case of two halfpennies, a lever Q, pivoted to the plate M, is rocked by the first halfpenny, so that its upper projection R is moved into position to support the second halfpenny, which performs the same function as a penny.

To allow for variations in the price of gas, the pin on the part E of the carrier is made adjustable.

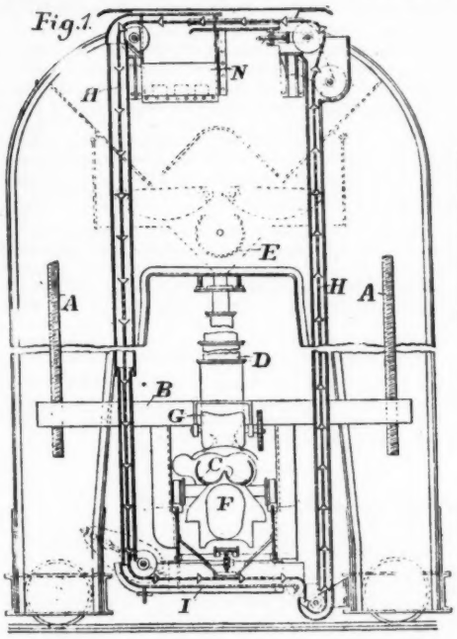
Charging Machines for Gas-Retorts.—No. 102,839.

WHITE, A. E.; a communication from the RITER-CONLEY MANUFACTURING COMPANY, of Leetsdale, Penn., U.S.A.

No. 857; Jan. 19, 1916.

In accordance with this invention, the machine is provided with mechanism which catches any material spilled in the charging operation and conveys it (say) to the charge-supply hopper. The arrangement is said to be particularly applicable to charging machines provided with a horizontally movable and vertically adjustable charger which is moved into different horizontal planes for the purpose of charging and discharging the retorts in various horizontal planes. The spilled material could then be conveyed by a vertically travelling elevator moving horizontally during a portion of its travel and running continuously, while the horizontally moving portion would be in proximity to the charger, and follow the vertical movements of adjustment of the charger.

The illustrations show the invention as applied to a charging machine which not only charges a retort, but also discharges the carbonized



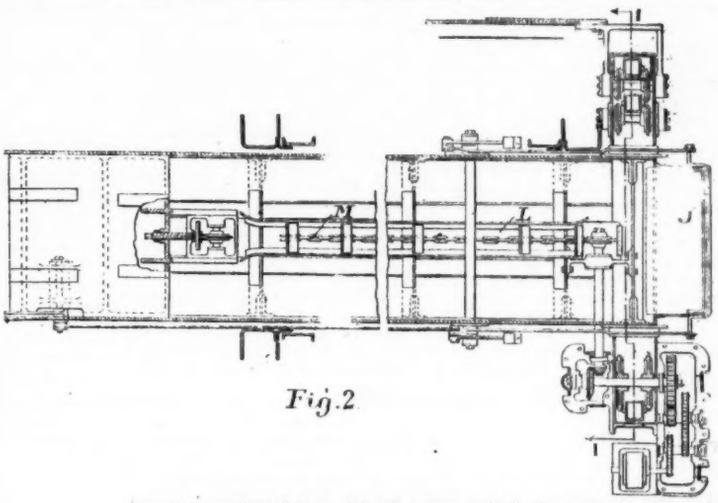
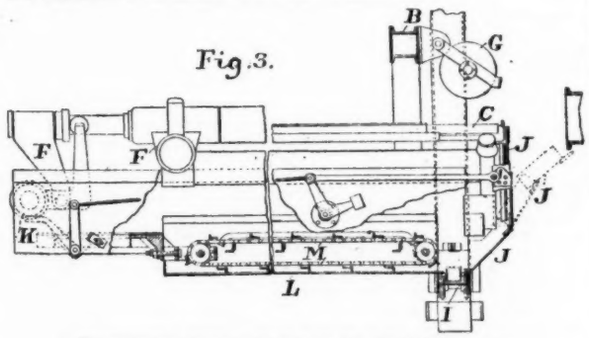


Fig.2



Riter-Conley Company's Retort-Charging Mechanism.

contents prior to charging it. Fig. 1 is a vertical sectional view of the machine on the line 1—1 of fig. 2. Fig. 2 is a horizontal sectional plan. Fig. 3 is a part side elevation and a part vertical section showing the horizontal travelling conveyor with relation to the charger.

The main frame of the machine is supported on wheels which travel along a track in front of the gas-benches (not shown). At the top, and extending longitudinally of the machine, is a hopper to contain the coal to be charged into the different retorts arranged on different horizontal planes. The mechanism for conveying the coal and discharging the coke is capable of being moved vertically by rotable screws A working in a horizontally disposed girder B and depending members. This frame-work is designed to carry the charger and discharger scoops C, as well as a telescopic shoot D extending from immediately below a coal-feeding mechanism E intermediate of the bin and the top of the shoot.

The scoops (particularly shown by fig. 3) are supported by, and movable with, a carriage F adapted to be moved longitudinally of the machine on a track carried by the vertically adjustable frame. G is a roller designed to bear upon the coal contained in the scoops, and shape it prior to its introduction into the retorts.

During the operation of charging (particularly when the charger is filled up to its charge conveying capacity), some of the coal is liable to be spilled, and to prevent this a vertically travelling spill elevator H is provided within vertically extended casings attached to the main frame of the machine.

The elevator H is provided with coal receiving buckets, passing over pulleys carried on the main frame of the machine; and, in addition, it runs on pulley and drive wheels supported from, and movable with, the vertically adjustable frame. This arrangement provides for a horizontal or lateral movement of the elevator during a portion of its travel, and for the horizontally travelling portion to be movable vertically with the vertically adjustable frame and the charger carried thereby—thus definitely spacing and positioning this portion relatively to the charger. The portion of the elevator having the horizontal travel and capable of being adjusted vertically moves through a trough I secured to, and movable with, the vertically adjustable frame.

In front of the machine, and in communication with the trough, is an adjustable spill collecting device adapted to be projected forwardly from the position shown in full lines in fig. 3 to the position shown in dotted lines, so as to enable it to be carried outwardly from the machine and under a retort. This adjustable shoot catches any coal that may be spilled between the end of the charging machine and the retort, and directs it downwardly into the trough. The forward and backward movement of the shoot is effected by weighted levers, connecting rope, and rods—the latter connected at opposite ends to levers on opposite sides of the machine, and secured to the adjustable shoot.

The return or closing movement of the spill collecting device is automatically effected by a roller K carried on the carriage F coming into contact with a lever as the charger is withdrawn from a retort, and is projected by weighted levers and their connecting rods after the roller K passes off it. In its closed or back position, a portion of the shoot extends into the path of travel of the charger; and as the charger moves forward, it will tend to move the shoot into its projected position shown by dotted lines.

Supported by the vertically adjustable frame and extending parallel with, and having a length at least equal to, the length of the charger and discharger, is a centrally disposed trough L, and adapted to operate within the trough is a conveyor M arranged to travel in a path at right angles with the horizontal travel of the elevator H. Thus any coal spilled into the trough L will be conveyed forwardly into the trough I, and any coal caught by the adjustable shoot will also be deposited in the trough, and thence carried, by the buckets on the elevator H, up to and into a small hopper N at one side of, and in communication with, the main hopper or bin at the top of the machine.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Jan. 24.]

Nos. 697—1039.

AJAX HEATERS, LTD.—"Heating-apparatus for liquids." No. 811.

AYLSWORTH, A. M.—"Process for producing phenol, &c." No. 883.

BAKER, H.—"Recovery of ammonium chloride from ammoniacal liquor, with extraction of cyanides, &c." No. 836.

GILL, J. F.—"Pressure-regulators." No. 835.

HARKINS, H. B.—"Gas-igniting devices or pilot lights." No. 743.

HELPS, G.—"Cookers, gas-rings, gas-fires, &c., and bunsen burners thereof." No. 1023.

MACLAURIN, R.—"Extracting dyes and dyeing-materials from low-temperature tars and liquors." No. 906.

MAYALL, W. H.—"Gas-supply regulators or governors." No. 1038.

MECHANS, LTD.—"Bolt couplings for flange joints of tubes, pipes, &c." No. 994.

PROCTOR, W. H.—"Ascension-pipes or flues of bye-product ovens, furnaces, &c." No. 805.

PURCELL, W.—"Automatic warning-trap for dry gas-meters, &c." No. 960.

SAUNDERS, S.—"Automatic controlling-means for heating and lighting installations, &c." No. 718.

SAVINGS INVESTMENT COMPANY.—See AYLSWORTH. No. 883.

SCHOFIELD, J.—See PURCELL. No. 960.

SNELL, C. SCOTT.—"Apparatus for compressing gas, air, &c." No. 700.

SPENCER, H. W.—See GILL. No. 835.

THOMSON, J.—See MECHANS, LTD. No. 994.

TIFFEN, T. B.—"Exhausting air and gases." No. 724.

WILLIAMS, J.—See MAYALL. No. 1038.

LEGAL INTELLIGENCE.

BYE-PRODUCTS RECOVERY PLANT.

Application in the Patents Court.

Before Mr. TEMPLE FRANKS (the Controller of Patents), sitting in the Patents Court on Wednesday last with Sir CORNELIUS DALTON, Simon-Carvès, Ltd., of No. 20, Mount Street, Manchester, applied for a licence to use two German Koppers patents, covering processes and apparatus for the recovery of bye-products from gases arising out of the carbonization of coal and coke. The patents are No. 20,870 of 1904 and No. 16,316 of 1905.

Mr. HUNTER GRAY appeared for the applicants. Mr. TERRELL, K.C., opposed on behalf of Mr. Victor Derry, one of the partners of the Koppers Coke-Oven and Bye-Products Company, of Glossop Road, Sheffield. Mr. RUDOLPH MORRIS represented the Controller of that Company under the Board of Trade.

Counsel explained that the applicant firm traded under the title of the Bye-Products Coke-Ovens Construction Company. The bye-products included tar and ammonia; and the recovery process was intimately related to the production of toluol and benzol, which were in great request just now for the making of explosives. It was desirable that the Government should be supplied with their material from as many quarters as possible, and many gas-works were giving special attention to this subject.

Mr. TERRELL took objection to the jurisdiction of the Court, which he said he intended to test in the Chancery Division. The objection was a serious one; and he requested that these proceedings should not continue until the Chancery Court had pronounced on the matter. The Patents Court was set up under the Patents, Designs, and Trades Marks (Temporary Rules) Act, 1914, and an amending Act. These Acts, by the amendment, applied to "any patent or licence, the person entitled to the benefit of which is a subject of any State at war with His Majesty." The war had automatically put an end to the partnership; and Mr. Derry, under a recent decision, was carrying on the firm with the assets vested in him, the others having merely a lien on them. The decision in an action brought by Stephenson and Son (16, 1 King's Bench, 763) drew a distinction as to the profit and loss account of the continuing business and the partnership assets. The beneficial interests in these patents being in Mr. Derry, they were not in the "subject of any State at war with His Majesty;" and the Patents Court could not hear the application.

The CONTROLLER said he should proceed. The hearing of evidence on behalf of the Board of Trade need not prejudice Mr. Terrell's application to the Chancery Court. The Board of Trade already had the case of the opposing firm under observation.

Mr. Terrell then left the Court with his client.

Mr. GRAY said the applicants were one of the largest contractors engaged, through their plant, in the supply of explosives to the Ministry of Munitions, by whom they were a controlled firm. They did not make the gases from which the tar and the ammonia were extracted. They were contractors, and provided the plant for the purpose. The figure representing the total cost of products supplied by or through their agency to the Government was £380,000. The Company were also large contractors to the French Government. In the distillation of coal and the process of making coke, certain gases were given off; and in the past the processes for the recovery of bye-products had lost a considerable amount of one or the other. These specifications first of all separated the tar, and then from the remaining gas the ammonia. As to Koppers, one could not help knowing that the practice had existed of Germans themselves holding patents in this country to prevent manufacture here—themselves, through an English branch, supplying the plant, the profits of which went entirely to the Germans. The applicants had complained of Koppers making slanderous statements to the effect that they were infringing the Koppers patents. The opponent firm had written to clients of Messrs. Simon-Carves, suggesting to them that the use of the latter's recovery plant would leave the purchaser open to risks of action of infringement; and the applicants had lost contracts in consequence. Messrs. Bird & Co., of London, took elsewhere an order for forty regenerative coke or waste-heat ovens. After the outbreak of war, the opposing Company was placed in the hands of the Controller. It was felt they might assist in the production of benzol and toluol for the British Government. On Jan. 14, 1916, there came a communication from a Sheffield solicitor, on behalf of Messrs. Koppers, suggesting that the applicant's heat coils in the ammonia saturator were an infringement of their patent; and the Controller of the Company must have had cognizance of a threat of proceedings which the letter contained.

Mr. MORRIS explained that the Board of Trade said no legal action was to be taken; and the view seemed to be that the matter should stand over until the conclusion of the war.

Mr. GRAY thought that it would be a monstrous thing if anybody could say: "You are infringing the patents of Germans, and must hold yourself liable to proceedings one, two, or three years hence." They could not carry on this particular business as long as these threats were held over their heads. They wanted a licence to make the plant and to cover the use of it. Gas bye-products were wanted for munition purposes. There were no alien shareholders in the applicant Company. There were four firms in this country who did the whole of the business of manufacturing this plant—the two now before the Court and the Otto and the Coal Distillation Companies; and both these were German, and had come under the observation of the Board of Trade. Koppers had carried on a policy which, he regretted to see, had been encouraged by their Controller. It seemed as though the Koppers Company was being kept alive, and the goodwill of it, for the benefit of Germans after the war. It was intolerable to the applicants to go on in this way. They wanted a licence, so that it would be in nobody's mouth to say that they were making an unauthorized quotation for an unauthorized manufacture. This was why they were there. They were prepared to pay royalty. The plant for recovering the tar and ammonia could be used with a number of other distilling plants. One might have a recovery plant to deal with the gases from twenty-five ovens. This was the ordinary size of a recovery plant the cost of which would be about £1000. It would involve some sort of heating coil. He suggested a royalty of £1 per oven. He admitted no infringement, but sought this licence simply as a sort of insurance against proceedings. The Board of Trade were subsidizing, and the Ministry of Munitions encouraging by every means, the manufacture of these things by anybody.

The CONTROLLER: It is quite obvious they are doing their duty in taking this line.

Mr. MORRIS: Anybody who makes toluol or benzol is the spoilt child of the Ministry of Munitions just now.

The Manager of the gas coke-oven department of the applicant firm said there was a large demand for this plant which would continue after the war. The threats of infringement had related principally to the method of recovering tar and ammonia, and the heating coils.

The CONTROLLER said he would report to the Board of Trade.

MISCELLANEOUS NEWS.

LEEDS CALORIFIC ORDER.

The first copy to come to hand of an Order made by the Local Government Board under the Gas (Standard of Calorific Power) Act, 1916, refers to the City of Leeds.

Down to the last clause, it follows practically on the same lines as the Sheffield Gas Company's Order made by the Board of Trade [see "JOURNAL" for Nov. 21, 1916]. In this case, however, the liberty allowed under the Sheffield and other Board of Trade Orders, for the company and local authority concerned to agree as to the apparatus and conditions for testing, is absent, obviously because there is no one with whom the Corporation could come to an agreement, and therefore they must comply with the prescriptions made by some competent authority—which, of course, in this case are the Metropolitan Gas Referees.

In the final clause, the sub-section relating to the free supply of suitable flat-flame burners is omitted; and the sub-section referring to permissible revision of the standard calorific power or prescribed pressure gives a period of five years from the date of the Order, and is in the terms of sub-section (*b*) of the Lea Bridge Order, quoted in last week's issue [p. 165].

Cheltenham Gas Company's Order.

The Order made by the Board of Trade for the Cheltenham Gas Light and Coke Company also follows the lines of that of the Sheffield Gas Company, but with the modification of the sub-section of clause 8 introduced into the Lea Bridge and Leeds Orders.

BRIGHTON AND ITS GAS SUPPLY.

Complaints as to Quality and Price.

At last Thursday's meeting of the Brighton Town Council, some discussion took place as to the price and quality of the gas now being supplied in the district—arising out of the report presented by the Lighting Committee.

Mr. TINDALL said he noticed that the Committee had had before them a report on the tests of gas supplied for the December quarter. He believed the report practically stated that the gas was of inferior lighting and heating capacity—being 25 per cent. under what it should be according to Act of Parliament, The Government, he knew, wanted the residuals from the gas for making explosives; and the public had in consequence willingly submitted to the inferior gas supplied. But his point was this: The public were only getting three-quarters of the lighting and heating power that they were before the war; and he did not see why the loss should be all on one side. Why should not the Company share the burden by losing a quarter of their profits? What it came to was that the public were being charged an extra 25 p.ct., and the Company should in some way be induced to meet the public by giving up some of their profits. The Company were applying for powers to make the present order of things permanent; and the Council were opposing. But that had nothing to do with the present position; and he urged that something should be done at once.

The TOWN CLERK said the Council were taking all the steps necessary in connection with the Company's application for a Calorific Power Order; but with regard to the present time they were ruled by the action of the Ministry of Munitions calling upon them to acquiesce in the reduction in the power of the gas. The point really before the Council was the application of the Company to make permanent that which the Ministry of Munitions had, for national reasons, asked should be done for the period of the war. This was, of course, on an entirely different footing; and the Corporation were taking every step to oppose the change being made permanent.

Mr. TINDALL: If we appeal against having to stand the whole of the loss, does not that strengthen our position?

The TOWN CLERK: No, I don't think it does. The matter is concluded so far as the present time is concerned by the action the Ministry of Munitions has taken on national grounds. The actual effect is that the quality of the gas has been reduced 10 per cent. The analysis of the gas at present shows that it is between 11 and 12 candle power, whereas the standard is 15 or 15½ candles.

Mr. BLACK said the public were certainly receiving gas of poorer quality than before the war; but the Government did not state that the Company were to still charge the same price as before. He did

not think the Government had said that the Company were to be well paid for their residuals, and yet charge the Brighton public as before for an inferior article. He suggested a letter being sent to the Ministry of Munitions asking what remedy the ratepayers possessed.

The TOWN CLERK said there was this consideration on the part of the Company—that they had had to provide plant for the extraction of the residuals necessary for the manufacture of high explosives.

Mr. BLACK: They get paid for that out of the residuals.

The TOWN CLERK: They don't get paid for the capital outlay.

Mr. BLACK: Then it is making the Brighton ratepayers pay for the residuals.

Alderman WELLMAN agreed that the matter was one of great importance, but hoped nothing would be done in a hurry. He suggested that the Committee should promise to give it their close attention.

Mr. HEUN (speaking on behalf of the Committee) said they would do this. His complaint against the Company was that they had not only reduced the quality of the gas, but from time to time had increased the price. This was a grievance, particularly among the poorer classes. During the last two years the price of gas supplied through penny-in-the-slot meters had been raised three times; and with that there was a reduction in the heating and lighting power of the gas. Whenever the analyses of the gas had come before the Committee the question had been raised. But it was not sufficient for the Committee to take it up—unless the public did so as well, the result would not be as effective as it should be. There was a distinct promise when the Company were allowed to lower the quality of their gas that they would consider a reduction in the price.

The TOWN CLERK said the price of gas had gone up 6d.—the cause being the same as necessitated the Council putting up the price of electricity. It was nothing to do with the reduction of quality. The reduction was not a voluntary act of the Company; it was imposed upon them by the Government.

The subject then dropped.

TOWN GAS FOR INDUSTRIAL PURPOSES.

A practical paper on the "Use of Town Gas for Industrial Purposes" has been contributed by Mr. John M'Isaac, Furnace Inspector, to the proceedings of the Glasgow Corporation Gas Department Foremen's Association.

He pointed out the advantages that were possessed by this over other kinds of fuel, and then proceeded to explain the various systems of heating by gas, so far as furnaces are concerned. In order to thoroughly understand each method, it is essential, he pointed out, that the limits of temperature should be known; and to assist in this matter, he exhibited a chart prepared by himself to illustrate the approximate flame temperatures of the different systems. In any case, said the author, it is a doubtful matter to guarantee definite results if the controls are neglected or difficult to judge; and he would like to see further improvements in the matter of control, when using the natural-draught furnace, in so far as secondary air and draught are concerned. Further, it would tend to help things if the burner control received a little more attention. In considering the use of high-pressure gas in preference to the air-blast system, he remarked, with regard to the question of escapes in the two systems, that in the case of gas it means additional running costs, and has to be paid for; but with the air, it matters little, and only serves to help the air supply in the room in which it occurs. For furnaces, he argued, much experimenting and improvement in burner design will have to be carried out before high-pressure gas will entirely replace the air-blast.

By way of comparison between the use of natural draught and air-blast, Mr. M'Isaac mentioned that he has recently converted a large glass-annealing oven measuring in the heated portion 15 ft. long × 5 ft. 6 in. wide, to air-blast, using two gas and air mixers as designed and patented by Mr. R. Halkett. The original system was natural draught, and consumed 1400 c.ft. per hour, taking six hours to heat up to 600° Fahr., with 22 burners in the furnace. With the new system, using two mixers and air at ½ lb. per sq. in., the gas consumption was reduced to 1085 c ft. per hour for the first two hours; then down again to 900 c.ft.; and finally was maintained at 600° Fahr. for 50 p.ct. less gas than the maximum used in the old system. The number of burners was reduced from 22 to 18.

NEW LONDON LIGHTING ORDER.

The Home Secretary has made the following Order under Regulation 11 of the Defence of the Realm (Consolidation) Regulations, 1914:

(1) Any public lamp or lamps in the Metropolitan Police District or the City of London which the Commissioner of Police, acting on the advice of the Field-Marshal Commanding-in-Chief, Home Forces, directs to be lighted or retained in lighting, must be lighted or retained in lighting accordingly, and must be reduced, shaded, or obscured as the Commissioner of Police may direct.

(2) The Lights (London) Order of Aug. 26, 1916, shall, except as otherwise provided in paragraphs (5) and (8) thereof, apply as follows:

During January	from 6. 0 p.m.	During June	from 9.30 p.m.
,, February	,, 6.30 p.m.	,, July	,, 9. 0 p.m.
,, March	,, 7.30 p.m.	,, August	,, 8.30 p.m.
,, April	,, 8.30 p.m.	,, September	,, 7.30 p.m.
,, May	,, 9. 0 p.m.		

Till one hour before sunrise, and according to Greenwich mean time, in each case.

This Order may be cited as the Lights (London) Order of Jan. 25, 1917; and this Order and the Lights (London) Order of Aug. 26, 1916, may be cited together as the Lights (London) Orders.

Suitable for use in all Modern Interior Coal Grates.

Artistic Gas Fires.

THERE are many of them, of course, but have you studied the "St. Nicholas" types?

The "St. Nicholas" Gas Fire is a happy combination of the three essentials:

Effective Radiation.
Effective Ventilation.
Effective Appearance.

And the result is *the* Gas Fire.

Low in Price and Easy to Fit.

Designed and constructed by

R. & A. MAIN, LIMITED.

WORKS: Gothic Works, **EDMONTON, N.**; Gothic Ironworks, **FALKIRK**; and Gothic Works, **BIRMINGHAM.**
SHOWROOMS AND BRANCHES: 25, Princes Street, Oxford Circus, W.; 136, Renfield Street, **GLASGOW**; 83, Old Market Street, **BRISTOL**; 18, Severn Street, Deansgate, **MANCHESTER**; 97, Millfield, **BELFAST**; 333, Queen Street, **MELBOURNE**; and 12, Cunningham Lane, Pitt Street, **SYDNEY, N.S.W.**

THE TRAVANCORE MONAZITE DEPOSITS.

Reference has been made on more than one previous occasion in the "JOURNAL" to a discussion in the columns of the "Indiaman" on the position of the Indian Geological Survey in reference to the discovery of the Travancore monazite deposits. An account of an interview with Sir Thomas Holland (lately the Director of the Survey) was followed by an article from a correspondent taking exception to some of the statements then made, and declaring that, while the scientific work was admirable, the "Travancore monazite muddle and the neglect of the Khewra potash deposits seem to indicate clearly that the Survey needs extraneous assistance from time to time to direct its energies into channels which will lead to the better utilization of the mineral resources of India for the benefit of India and the Empire at large." In reply, Sir Thomas Holland, while recognizing the occasional need of external assistance, laid stress on the qualities of the advisers from whom assistance should be sought.

Dealing now with the matter editorially, the "Indiaman" says: "Our correspondent thought that some remarks in our columns on this subject might have conveyed to a 'superficial reader' the impression that the Travancore deposits of monazite were discovered by the Geological Survey. Nothing that we have said could reasonably bear this interpretation. But the claim has, in fact, been put forward elsewhere; so it is as well to state clearly that it has not been made by the Survey or by Sir Thomas Holland. There is no doubt that the credit of the discovery belongs to a prospector who was working in the Travancore State. Our correspondent, however, argued, not merely that the Survey did not make the discovery, but that it ought to have done so; that it refused to look for thorium minerals when urged to do so; and, further, that it failed to make the discovery known, and thereby contributed to the German monopolization of the deposits, Consequently, Sir Thomas Holland was not justified in attributing this result to 'the carelessness, or worse, of English scientific men and manufacturing technologists.'"

Proceeding to answer these contentions, our contemporary points out that the deposits in question lie outside the territory of the Geological Survey. They occur in the Travancore State, which has its own geologists, related to those of British India by no administrative tie, but solely by the fraternity of science. As regards the allegation of delay in publishing the discovery when made, Sir Thomas Holland makes it clear that the information was given in the first possible issue of the "Mineral Production of India;" and the Survey could not have done more than give the information at the earliest opportunity in their appropriate publication.

The remarks of the "Indiaman" on the next head are: "Nor can we follow our correspondent's inference that the German monopoly was facilitated by the action of the Geological Survey. In the first place, there was, in the strict sense, no monopoly, because the concession covered a part only of the known deposits; and, in the second place, the information that these deposits existed was on record, and available to any other firm who might desire to obtain a concession. The use of the term 'German monopoly' is, however, in itself unsuitable. It is well known that, on the discovery of these deposits, the Indian Government provided that the concession should be given only to a British Company, and that the Company in question had its offices in London; while we are informed that it filled the single British order for monazite received up to the beginning of the war. The fact that the shares were held in trust for a German Company was, of course, not disclosed; and had it been disclosed, we are not aware that any interference was possible under the law as it stood up to the outbreak of the war. The Germans had secretly penetrated this industry, like some others; but to speak of a German monopoly in this connecton is calculated to import prejudice into a discussion where it is peculiarly out of place. We come, then, to Sir Thomas Holland's view that it was the fault of English scientific men and manufacturing technologists, and not of the Indian Government or of any of its Departments, that Englishmen could not, or did not, get monazite from Travancore. We fail to see what more could have been done by the authorities, unless they had attempted to override either the provisions of English company law or the political arrangements in force with the Travancore State; and, as regards the latter alternative, no one who knows anything of India would suggest this course for the sake of all the minerals contained in the country.

The existence of the deposits was announced in 1910; and at that time no more active measures would have been considered appropriate. We are all very much wiser now; but looking at the affairs of 1910 with the eyes of 1916 is not permissible. An English manufacturer who wanted thoria in 1910 or later could know that the mineral was being worked in Travancore by a British Company; he could place his order with the Company in its London office; and the only precedent in existence suggests that his order would have been filled. Trade was, to all appearance, free; and nobody can suppose for a moment that any Government Department of the *ante bellum* type would have tolerated any further interference with the palladium. It was for the manufacturer to act; and we have never heard that he attempted to do so. To refute Sir Thomas Holland's view, it would be necessary to show that specified English manufacturers had sought thoria from India in vain; and this our correspondent has not attempted to do."

Finally, the article records our contemporary's conclusion that the "correspondent's thesis regarding the work of the Geological Survey, and of Sir Thomas Holland as its Director, was not justified by the facts and arguments advanced in its support."

Mr. S. E. Bastow, for the past four years Joint Manager of Messrs. Bruce Peebles & Co., Ltd., of Edinburgh, has been appointed Chief Engineer to British Dyes, Ltd., with headquarters at Huddersfield. Mr. John H. Bunting, for the last four years Joint Manager of the Edinburgh firm, has been appointed their General Manager.

The Davis Domestic "Burn-All"

(GAS HEATED)

consumes house refuse at its immediate source

84/- *subject.*

Less trouble to fix than a Gas Fire.

Every "Burn-All" hired out therefore means ONE ACCUMULATION LESS to harbour disease germs, to emit objectionable odours, to encourage flies, and to increase the present difficulties of refuse collection and disposal.

—truly a National Service

THE DAVIS GAS STOVE CO., LTD., 60, Oxford Street, London, W.

GAS IN EDINBURGH IN THE OLDEN DAYS AND NOW.

Centenary of the "Scotsman."

On the 25th inst., the proprietors of the "Scotsman" published a supplement in celebration of its centenary, the first number having made its appearance on the 25th of January, 1817—a Burns anniversary. The paper began its career as a weekly publication at the price of 10d. In the first number there was this paragraph: "The subscription for lighting the City of Glasgow with gas is filling up; the Magistrates and Council subscribe £500, and the College £200."

Of the numerous advertisements appearing in the supplement, that of the Edinburgh and Leith Gas Commissioners is the most interesting, even after making due allowance for bias. The upper part is a pictorial representation of the old oil-gas works at Canonmills in 1824—the concern owned by a Company of which Sir Walter Scott was for some time Chairman, and whose property was purchased by the Edinburgh Gaslight Company in 1828. Contrasted with this picture, is an illustration showing the gas-works at Granton as they appear to-day; beneath which is a reproduction of a photograph of the all-gas kitchen in the Commissioners' show-rooms.

The following advertisement, which appeared in the "Scotsman" in 1823, is also reproduced, and makes interesting reading:

CLOSE OF
BELSHAZZAR'S FEAST AND JOSHUA,
BY GAS LIGHT,
AT
THE CALTON HALL, WATERLOO PLACE.

THE public is respectfully informed, that the Exhibition, by Gas Light, of these celebrated Pictures *WILL CLOSE* on the evening of Saturday the 29th inst.

Open during the day from 10 till 4 o'clock; in the evening by Gas Light, from 7 till 9.

Admittance One Shilling.

*** The brilliancy of gas not only shews to great advantage the various and rich assemblage of objects contained in these pictures, but gives them a peculiarly delicate appearance. It sheds a softened radiance over them, and imparts an effect and a beauty somewhat similar to the effect of moonlight on the landscape, when contrasted with the glow of day.

Taking this old advertisement as a text, the following neat little homily is preached upon it: "Note the curious way in which gas was presented as a novelty. Even then, with the old 'batswing' burner, the value of gas as an illuminant was noteworthy. To-day, after nearly a hundred years, the use of gas has passed from being a novelty into an established everyday custom; and gas is now the most important agent in all large cities for the production of light, heat, and power. The enormous strides which have been made in the manufacture, purification, and distribution of gas, and the production of appliances for its economical utilization since 1823, are demonstrated in the streets of every large town and in every home and factory, while the perfection of the inverted incandescent gas-mantle has carried gas beyond the stage when it could be referred to as 'the effect of moonlight on the landscape,' to the point of being almost precisely equivalent to the sun's own rays—turning night into day."

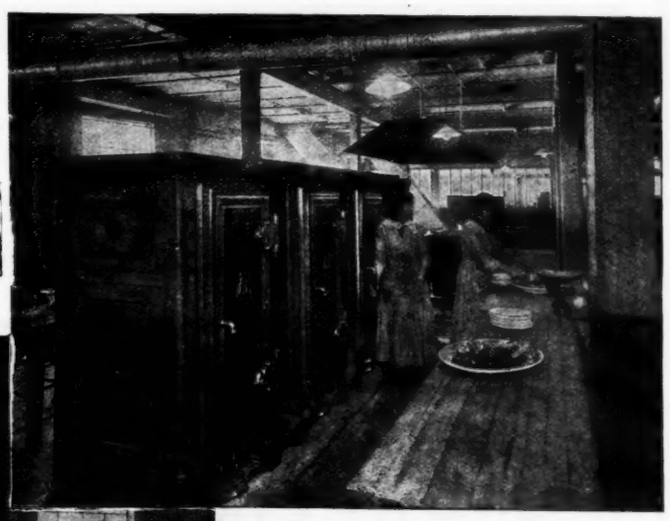
GAS-HEATED FURNACES.

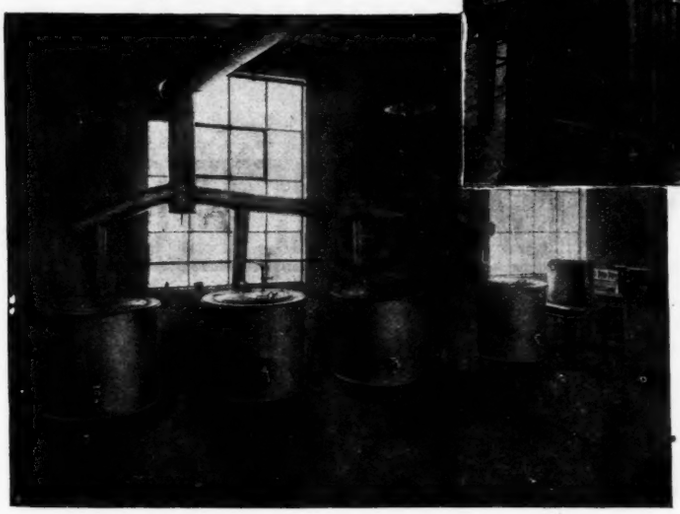
The "Times Engineering Supplement" of Friday last contained the following:

A crucible tilting furnace recently introduced by Messrs. John Wright and Co., of Birmingham, is so designed that the axis upon which it is tilted is in line with the lip of the crucible—the pouring point thus being a constant one. The body of the furnace is lifted by means of chains running in rockers attached to the front of its base and passing over machine-cut sprocket wheels connected to hand-operated gears. When the furnace body is resting on its base, it is covered by a preheating arrangement, which can be moved to one side by the aid of a lever and cam. In the centre of the iron frame of the preheater, which is lined with fire-brick, there is a sleeve which corresponds with, and rests upon, the top of the crucible. This sleeve, being filled with metal, extends the capacity of the crucible, and thus avoids the necessity of adding fresh metal as the charge in the crucible melts and settles down. The bottom of the furnace is provided with drop-doors for slagging and cleaning purposes; and there is also a pan which collects the metal in the event of the crucible breaking. Heating is effected by burners which consume gas at ordinary pressure; air being supplied to them at a pressure of 3 lbs. per square inch from rotary positive pressure or turbo blowers.

Furnaces of this kind are being used for casting strips of metal which are to be rolled into sheets. The strip moulds are successively brought under the pouring lip by a revolving turntable, or are carried on trolleys running on rails in front of the furnace. In this way the full charge of the crucible, the largest size of which contains 600 lbs. of brass, is poured without waste of time—each mould being filled in about a minute. In the experience of one firm using a furnace of 100 lbs. capacity and working a twelve-hour shift, fourteen melts per furnace are obtained, as compared with eight to ten with coke-fired furnaces of similar size. The average gross time per heat is 48·8 minutes, and the net time, after deduction for charging and pouring, is 39·2 minutes, although the work in this case requires a higher temperature than usual. The gas consumption is 7548 c.ft. per ton, costing 16s. 0½d. with gas at 2s. 1½d. per 1000 c.ft., whereas with coke-fired furnaces, giving a smaller number of heats per day, the fuel cost is 17s. 10½d. per ton of metal melted.

ARDEN HILL'S
Gas-heated
COOKING,
HEATING, &
HOT-WATER
APPARATUS





FOR CANTEENS,
HOSPITALS, &c.

New fully illustrated List now ready. — Write to

ARDEN HILL & CO.,
Acme Works,
BIRMINGHAM.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Jan.* 29.

Pitch continues in good demand; and business is only restricted by lack of shipping opportunities. Makers' present idea of price is 23s. to 24s. per ton net in bulk at makers' works. The export of creosotes and heavy oils has been prohibited; and it is understood that the Government will purchase all available supplies—*i.e.*, after allowing for quantities sold for home purposes—of creosote for the present year at the price of 67s. 6d. net per ton, *ex* installations at the various ports or f.o.b. the Thames. Other products generally remain unchanged.

In sulphate of ammonia there is a good demand for home consumption at Government prices. Export business is at present at a standstill, owing to the restriction of licences.

Tar Products in the Provinces.

Jan. 29.

There is nothing fresh to report concerning the markets for tar products. On the whole, prices remain the same.

The average values of gas-works products during the past week were: Gas-works coal tar, 19s. 9d. to 23s. 9d. Pitch, East Coast, 16s. to 16s. 6d. per ton; West Coast—Manchester 15s. to 15s. 6d., Liverpool 16s. to 16s. 6d., Clyde 17s. to 18s. Benzol, 90 p.ct., North, 10½d. to 11½d.; 50-90 p.ct., naked, North, 1s. 3d. to 1s. 4d. Toluol, naked, North, 2s. 3d. Coal tar crude naphtha, in bulk, North, 6¼d. to 6½d. Solvent naphtha, naked, North, 1s. 8d. to 1s. 9d. Heavy naphtha, North, 1s. 2d. to 1s. 3d. Creosote, in bulk, North, 3⅛d. to 3⅜d. Heavy oils, in bulk, North, 3⅜d. Carbolic acid, 60 p.ct., East and West Coasts, 3s. 4d. naked. Naphthalene salts, 80s., bags included. Anthracene, "A" quality, 2¾d. to 3d. per unit; "B" quality, ¾d. to 1d.

Sulphate of Ammonia in the Provinces.

LIVERPOOL, *Jan.* 27.

Further restrictions having been placed on the export of this material by the Ministry of Food, the market has become inanimate during the past week, and values have receded a little more. The closing quotations for early delivery are £18 10s. per ton f.o.b. Hull, £18 15s. f.o.b. Liverpool, and £18 17s. 6d. f.o.b. Leith. There has not been much interest shown in the forward position, either by buyers or by sellers, and no first-hand transactions have been reported.

Nitrate of Soda.

The tone of this market has continued strong, and holders on spot now require 21s. per cwt. for ordinary quality, and 21s. 3d. for refined.

Sulphate of Ammonia.

From another source, prices to-day are reported nominal; the export having been prohibited. Outside London makes are quoted £17 7s. 6d.; Hull, £18 10s.; Liverpool, £18 12s. 6d.; Leith, £18 12s. 6d.; Middlesbrough, £18 10s.

COAL TRADE REPORT.

Northern Coal Trade.

Though there is a good inquiry for all classes of coal, the lack of steamers hinders exports. Best Northumbrian steams are from 29s. to 30s. per ton f.o.b., and second-class qualities are about 22s. 6d. to 24s. Steam smalls are not quite so plentiful, and vary from 16s. 6d. to 21s. 6d. per ton, according to class. Production of steam coal is somewhat limited; licences to export being granted rather sparsely, and the rates of freight are very firm, especially for neutral ports. In the gas coal trade, the demand is full both for home use and for export. The output is therefore well taken up, especially on account of the long contracts. Prices do not show very much alteration. Best Durham gas coals are from 27s. 6d. per ton f.o.b., for second-class descriptions the current quotation is 20s. to 21s., and for "Wear specials" the price is about 30s. to 32s. 6d. There is pressure in the prompt requirements; the keen weather having enlarged the consumption, so that the stocks have wanted replenishing. Home needs have, however, been fairly met. The calling-up for enlistment of more men from the collieries will affect the future output; but the time of the heaviest consumption of gas coals is passing, and a week or two more will lessen the needs, unless for adding to stock. Good gas coke is still quoted at from 33s. to 34s. 6d. per ton f.o.b., according to the place of shipment. The freight on coke to the northern ports of France is based on about 46s. from the Tyne to Dunkirk, with variation according to the size of the steamers,

Though an active man in connection with the administration of gas companies' affairs, it is not alone the present and the future with which Mr. A. W. Oke concerns himself. He finds time to devote to a study of the happenings of bygone days; and a result of this research has been a very interesting paper on the "Bicentenary of Thomas Gray," which he read at a recent meeting of the Brighton and Hove Natural History and Philosophical Society.

IF YOU ARE RECOVERING
BENZOL
AVOID THE COMING
NAPHTHALENE STOPPAGES
AND FIX AT ONCE A
PARAFFIN CARBURETTOR.
R. & J. DEMPSTER LTD.
MANCHESTER.
LONDON OFFICE
165 GRESHAM HOUSE,
OLD BROAD ST. E.C.

Lord Chetwynd on "T.N.T." Poisoning.

Viscount Chetwynd, the Managing-Director of a munitions factory in the Midlands, speaking on "T.N.T." poisoning at a meeting of the Royal Society of Medicine, said that, from an administrative point of view, the complete elimination of sickness among the operatives of a filling factory was of even greater importance than production, in view of the shortage of labour. He had formed an opinion that the dangerous types of poisoning such as this were due, not so much to the explosives when in the form of dust, as to the fumes arising from the material, although the dust was undoubtedly irritating, and must be suppressed. To eliminate the fume and mitigate its effects, a ventilating scheme must be installed which provided a constant current of air pure and fresh flowing from the ceiling to the floor—extraction necessarily being effected from the floor level. This system was in course of installation at the factory with which he was connected. An interesting fact was that the considerably larger number of gastric cases which he found existing among women than among men led him to make inquiries as to the food that the women were in the habit of taking. He found as a result that, whereas the men would have substantial meals, the women would satisfy themselves with a bun or two and a cup of tea. He decided that it was in the interests of the factory that the women should be properly fed; and, accordingly, a deduction from their pay was made, and they were fed. The deduction from their pay did not cover half the expense of feeding them; but the extraordinary improvement in their health made the financial transaction a satisfactory one.

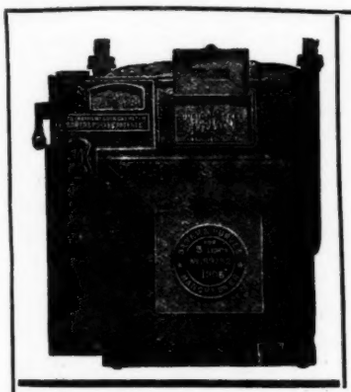
A Plea for Better Lighting in London.—Through the columns of the "Pall Mall Gazette" some days ago, Lord Sydenham pleaded strongly for more light in London, and he is unable to bring himself to believe that the present darkening of the streets, which is not only dangerous, but at the same time exceedingly depressing, need be carried as far as it now is. He admits that the difficulties of ensuring a general reduction of lighting to any standard which may be laid down at a precise hour are naturally considerable, but says that, so far as street lighting is concerned, it must surely be possible to turn out a portion of the lights at any time that might be fixed, while as regards shop-lights the police would quickly be able to ensure compliance with the regulations. If this improvement is impossible, he would, at any rate, like to see uniformity observed, instead of the "present inequality of lighting in different areas." On the same subject, Mr. Ingleby Oddie, the Lambeth Coroner, said at an inquest that he had been looking up the statistics of his own district; and the result was very striking. In October, November, and December, 1913, there were 17 inquests due to street accidents. In the same months in 1916, there were 47. There were eight London Coroners; and if these figures were multiplied accordingly, it would be found that a terrible state of affairs existed during the hours of darkness.

Public Lighting of Cardiff.—Following on a deputation to the Home Office, the Chief Constable of Cardiff (Mr. David Williams) has given instructions that a certain number of lamps are to be relighted, subject to suitable shading.

Crook (co. Durham) Gas Company.—No dividend will be paid by this Company on last year's working, which the Secretary (Mr. W. D. White) reports involved a loss of £26 6s. Usually the dividend paid has been 10 p.ct. The deficit is attributed to the increased cost of materials for production and distribution, as well as to the suspension of all public lighting.

Manchester Trading Profits Special Committee.—On April 1, 1914, the Manchester City Council decided that the contributions of the Trading Committees in relief of the rates should be the following amounts per annum, and that such sums should be the fixed annual contributions for the next three years: Gas Committee, £50,000; Electricity Committee, £30,000; Tramways Committee, £100,000; Markets Committee, £17,000—total, £197,000. This arrangement comes to an end by effluxion of time on March 31 this year; so that the question will have to be further considered and decided upon before the preparation of the next annual estimates. Hence the appointment of the Trading Profits Special Committee, to go thoroughly into the whole subject.

Another "T.N.T." Poisoning Case.—At an inquest held at Nottingham on the death of a munition worker named Edith Perkins, aged 21, which took place at the Nottingham General Hospital last Saturday week, it was given in evidence that the deceased complained on the 6th inst. of feeling ill, and remained at home. She consulted a local doctor, who prescribed medicine and advised her to rest for a few days. She was treated for jaundice, but her condition became worse, and on the 16th inst. she was taken to the hospital. One of the Lady Doctors at the hospital said that the girl was suffering from "T.N.T." poisoning when admitted. Except for evidence of jaundice and degeneration of the liver, all the organs were healthy. The Staff Superintendent at the factory, at which the girl had been since last August, said she was engaged on trucking empty shells and taking them to the filling cylinder. After three months she was medically examined and found to be all right. On removal to another part of the place, where she was also employed on trucking shells, it was considered that the work was too heavy for her, and she was again moved. On her last work she remained only three days. Rigid precautions were adopted in respect to the health of the employees, who were carefully advised as to their diet and habits. Witness was told that the girl complained to a fellow-employee of having a headache before she left the factory; and when he learnt of her illness a medical officer was sent to her home. In answer to the foreman, the Superintendent said all employees engaged had to submit to medical examination; and no deaths had previously occurred among those who had been examined. A verdict was returned to the effect that deceased died from "T.N.T." poisoning.



The "Positive"

"THE METER OF MANY MERITS."

SAWER & PURVES, BRANCH OF METERS LTD.

MILES PLATTING, MANCHESTER.

RADFORD ROAD, NOTTINGHAM.

Agent for Scotland: JNO. D. GIBSON, 2, CAUSEYSIDE STREET, PAISLEY.

Ironmongers and Gas-Mantles.—It may be remembered that at a meeting, towards the end of last year, of the Manchester District Ironmongers' Federation it was proposed to adopt an "Association gas-mantle" with a special registered name. At the meeting on the 16th inst., however, the opinion was generally expressed "that the time for definite action was not just now.

The Manchester Lighting Deputation.—The deputation from the Manchester Corporation (which included Alderman Kay, the Chairman of the Gas Committee), returning from a tour of investigation of the lighting of other towns, declined to be formally interviewed; but a writer in the "Manchester Guardian" says they have given him a fairly definite indication that their report will show that, on their tour of four towns in the East Midlands (Leeds, Sheffield, Nottingham, and Leicester) and Birmingham, they have seen no public lighting equal to that of Manchester. As regards both the area lighted and the amount of light allowed, Manchester's plan is to be preferred. In none of the four East Midland towns did they find more than 4 p.ct. of the lamps lighted. In Manchester, 20 p.ct. of the lamps are lighted. In the East Midland towns, all the lights are extinguished not later than 11 o'clock, and in one case as early as 7.30. In none of them is there any early morning lighting or any lighting of the suburbs.

Fixing Gas-Stoves in the Nottingham Corporation Area.—At the monthly meeting, on the 10th inst., of the Nottingham and District Ironmongers' Association, further correspondence was read from the Gas Manager (Mr. J. Wilkinson) about the price allowed for the fixing of gas-fires, in which he agreed to a further 1d. per hour for men and ½d. for apprentices. While it was considered this did not leave a very big margin, it was decided to thank him for his efforts.

Wages Arbitration at Rochdale.—Further concessions have been made by Departmental Committees of the Rochdale Corporation to various sections of their workpeople who recently asked for substantial advances (round about 8s. per week) in their wages, to meet the increased cost of living. The proposal of the Joint Committee is that 6s. 6d. per week should be granted as a bonus for the period of the war and for six months thereafter; this amount to include any advances or war bonuses received since the outbreak of war. The proposal has been accepted by the representatives of the employees. The gas-works labourers were included in the original demand for increased wages; but as the department is a certified undertaking under the Ministry of Munitions, the Gas Committee adhered to their decision to apply to the Committee on Production for arbitration on the demands of the men.

STOCK MARKET REPORT.

THE Stock Exchange has had another quiet week, with business on a very reduced scale; some markets being particularly somnolent. The general tendency, with a few special exceptions here and there, has been downward, as realizations (or attempts at realization) of securities in order to provide money for War Loan investment were attended with a marking-down of prices. Everything was, of course, ruled by the War Loan; and speculation is keen as to how much new money it will produce. The path to a big success is almost weekly being improved by the removal of uncontemplated obstacles and by the granting of wider facilities for investment. Last week a notable improvement was announced in regard to the levelling up of odd amounts resulting from the conversion of issues convertible into the new loan—a concession which should have valuable results.

In the gilt-edged market, the 4½ per cent. War Loan made a good show of firmness; but Consols had further downward steps towards a 5 per cent. price. On Thursday, 52½ was touched, and on Friday the record figure of 51½ was marked. In Home Rails, outside some inquiry for prior charge issues, the tendency was flat. The Foreign Market was very quiet throughout, particularly so after the mobilization scheme came out. French Loans were the firmest point. Americans and Argentines were dull, and South Africans irregular.

In the Gas Market, business showed more animation, and there was a better array of transactions than the average run of recent weeks. Gas Light and Coke issues were more active, and the price of the ordinary hardened; the accounts for the half year apparently being well received. Increased activity in the market will be welcomed, if it but draw attention to the very low prices to which some choice lines have drooped through sheer stagnation. In the Money Market, very easy rates prevailed for awhile, hardening somewhat before the close.

Bargains done for cash during the week were as follows: On Monday, Commercial 4 p.ct. 73½, Gas Light ordinary 70½, 71, 71½, ditto maximum 56½, 56½, ditto preference, 69¾, ditto debenture 56½, 56¾, Imperial Continental 73, Primitiva preference 58s. 9d. On Tuesday, Buenos Ayres debenture 59, Gas Light ordinary 71, 71¼, ditto maximum 56½, 56¾, 56¾, ditto preference 70, Imperial Continental 70, Primitiva preference 60s., South Metropolitan 77⅛, 78, Reigate ordinary 146¼, 146¾, ditto shares 7¼, 7 5/16. On Wednesday, British 34⅝, Buenos Ayres debenture 59½, Commercial 4 p ct. 73½, European 9½, 9½, Gas Light ordinary 70¾, 71, 71¼, 71½. Imperial Continental 75, South Metropolitan 77¾, 78, South Suburban 80¾, 81. On Thursday, Brighton and Hove debenture 82½, 83, Gas Light ordinary 70⅝, 70¾, 70⅞, 71, 71⅛, ditto maximum 56½, 56¾, ditto preference 69½, 69¾, 70, Imperial Continental 73, 75, Monte Video 8, Primitiva preference 57s. 6d., South Metropolitan 77½, 78½, South Suburban 80¾, 81. On Friday, Commercial 4 p.ct. 74½, Gas Light ordinary 70⅝, 72, ditto preference 70, 70½, Ilford "B" 83½, 84. On Saturday, Gas Light maximum 56½, 56¾, Imperial Continental 74½, Primitiva 40s. 4½d., South Metropolitan 77½, 78, 78½.

The Bank rate is 5½ p.ct., as fixed on the 18th inst.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue.	Share.	When ex-Dividend.	Previous Div or Dividend and Bonus.	Last Dividend.	NAME.	Closing Prices. July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
175,472	Stk.	Mar. 10	4	4%	Aldershot 4 p.c. Pref.	..	65—70	..
1,551.868	,,	April 8	2½	5⅛%	Alliance & Dublin Ord.	59—64	62—64	..
874,000	,,	July 10	4	4%	Do. 4 p.c. Deb.	76—79	58—63	..
280,000	5	April 29	7½	4%	Bombay, Ltd.	5⅝—6⅜	5—5½	..
50,000	10	Feb. 26	16	15/-	Bourne-mouth Gas and Water { 10 p.c.	29 30	25—27	..
388,110	10	,,	7	7/-	B 7 p.c.	15—15½	11—11½	..
115,000	10	,,	6	6/-	Pref. 6 p.c.	13¼—14	9½—10	..
159 740	—	,,	—	4%	4 p.c. Deb.	..	71—73	..
992,045	Stk.	Feb. 26	†14	55/-	Brentford A Consolid.	261—266	85—87	..
734.920	,,	,,	†11	53/9	Do. B New	204—209	82—84	..
55,000	,,	,,	5	5%	Do. 5 p.c. Pref.	109—111	85—90	..
221 400	,,	June 11	4	4%	Do. 4 p.c. Deb.	91—93	67—69	..
217 380	,,	Feb. 26	11	10½%	Brighton & Hove Orig.	208—213	160—165	..
244,200	,,	,,	8	7¾%	Do. A Ord. Stk.	154 - 159	115—120	..
530 000	20	Mar. 26	12½	22/6	British	44—45	34—35	34⅜
120,000	Stk.	June 26	4	4%	Do. 4 p.c. Deb. Stk.	88—90	66—68	..
245.771	,,	,,	4	4%	Buenos Ayres 4 p.c. Deb.	85—87	58—63	59—59½
100.000	10	—	—	—	Cape Town & Dis., Ltd.	1¾—2⅛	1¾—1¾	..
100,000	10	—	—	4¾%	Do. 4½ p.c. Pref.	4—6	4½—5	..
100,000	Stk.	June 26	4½	4½%	Do. 4½ p.c. Deb. Stk.	70—75	58—63	..
157.150	,,	Feb. 26	5	5%	Chester 5 p.c. Ord.	108—110	82—83	..
1,513.280	,,	Feb. 12	5/9/4	49/4	Commercial 4 p.c. Stk.	106—108	73—75	73½—74½
560 000	,,	,,	5⅓	46/8	Do. 3½ p c. do.	103—105	68—70	..
475,000	,,	June 11	3	3%	Do. 3 p.c. Deb. Stk.	69½—71½	52—54	..
800,000	,,	,,	4	—	Continental Union Ltd.	76—79	36—38	..
200,000	,,	,,	7	—	Do. 7 p.c. Pref.	115—118	58—60	..
278,400	—	—	—	11½%	Croydon B and C 7 p.c..	..	175—185	..
—	—	—	—	10%	Do. E	..	..	..
492,270	Stk.	—	6	5¾%	Derby Con. Stk.	123—125	100—105	..
55.000	,,	—	4	4%	Do. Deb. Stk.	102—104	80—83	..
1,003,180	10	July 29	10	7/6	European, Ltd.	17—18	9—10*	9½—9½
16,313 430	Stk.	Feb. 10	4/17/4	42/-	Gas Light and Coke { 4 p.c. Ord.	98—102	71—73	70½—72
2,600 000	,,	,,	3⅜	3⅜%	3½ p.c. max.	76—79	55—58	56½—56¾
4,062,235	,,	,,	4	4%	4 p.c. Con. Pref.	96—99	69—71	69¼—70½
4,674 850	,,	June 11	3	3%	3 p.c. Con. Deb.	72½—74½	55—57	56½—56¾
130.000	,,	,,	10	10%	10 p.c. Bonds	..	..	..
258,740	,,	Mar. 12	5	4¼%	Hastings & St. L. 3½ p.c.	87—89	78—83	..
70.000	10	April 29	11	6%	Hongkong & China, Ltd.	16½—16¾	8—9	..
86,600	—	—	—	9½%	Hornsey 7 p.c..	..	125—135	..
131,000	Stk.	Mar. 12	7⅞	7⅛%	Ilford A and C.	151—154	105—110	..
65,780	,,	,,	6⅜	5¾%	Do. B	115—118	82—87	83½—84
65.500	,,	June 26	4	4%	Do. 4 p.c. Deb.	92—94	71—74	..
4,910,000	,,	May 14	9	4½%	Imperial Continental	150—160	73—78	73—75
1,235,000	,,	Feb. 12	3½	3⅜%	Do. 3½ p.c. Deb. Red.	84—86	65—67	..
235,242	,,	Mar. 12	6½	6½%	Lea Bridge Ord. 5 p.c.	119—121	87—92	..
2,498,905	,,	Feb. 26	10	5%	Liverpool 5 p.c. Ord. { A	211—213	85—87	..
					{ B	146—148		..
306.083	,,	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	..	74—76	..
75,000	5	June 11	6	2/-	Malta & Mediterranean	4½—4⅝	3¾—4½	..
250,000	100	April 1	4½	4½%	Met. of Melbourne { 4½ p.c. Deb.	99—101	80—93	..
541,920	20	May 28	4	6/-	Monte Video, Ltd.	11½—12	8—8½	8
1,875,892	Stk.	July 29	4½	4½%	Newcastle&Gatsh'dCon.	98½—99½	74½—75½	..
529,705	,,	June 26	3½	3½%	Do. 3½ p.c. Deb.	82—83	73—75	..
55,940	10	Feb. 26	7/14/0	7/8⅝	North Middlesex 7 p.c..	14—15	10½—11½	..
300,000	Stk.	May 14	8	8%	Oriental, Ltd.	117—122	104—106	..
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd.	7½—7¾	2—3	..
60,000	50	Feb. 26	13	12%	Portsea, Island B	128—131	95—100	..
100,000	50	,,	12	11%	Do. C	118—121	88—93	..
52,000	50	,,	10	9%	Do. D	..	..	..
249,980	5	April 29	8	—	Primitiva Ord.	5½—6	1⅞—2¼	40/4½
499,960	5	June 26	5	2/6	Do. 5 p.c. Pref.	4⅞—5	55/—65/-	57/6—60/-
521,600	100	June 2	4	4%	Do. 4 p.c. Deb.	91—93	78—80	..
—	—	—	—	4%	Do. ,, ,, 1911	..	..	..
346,198	Stk.	June 26	4	4%	River Plate 4 p.c. Deb.	85—87	61—67	..
150,000	10	May 14	6	6/-	San Paulo { 6 p.c. Pref.	10½—11	8—8½	..
125,000	50	July 1	5	5%	5 p.c. Deb.	47—49	42—44	..
135,000	Stk.	Mar. 12	10	10%	Sheffield A	223—224	188—192	..
203,984	,,	,,	10	10%	Do. B	222—224	188—192	..
523 500	,,	,,	10	10%	Do. C	220—222	188—190	..
90,000	10	May 28	9	6/-	South African.	10½—11⅛	..	..
6,609,895	Stk.	Feb. 10	5/4/0	44/-	South Met. 4 p.c. Ord.	111—113	77—79	77½—78½
1,895,445	,,	July 10	3	3%	Do. 3 p.c. Deb.	72½—74½	55—57	..
221,820	,,	Feb. 26	8½	8%	South Shields Con. Stk.	157—159	144—146	..
952,795	,,	,,	6	48/4	S'th Suburb'n Ord. 5 p.c.	114—116	80—82	80¾—81
60,000	,,	,,	5	5%	Do. 5 p.c. Pref.	110—112	79—81	..
135 000	—	—	—	48/4	Do. West Kent	..	..	..
187,558	Stk.	June 26	5	5%	Do. 5 p.c. Deb. Stk.	116—118	88—90	..
647,740	,,	May 14	5	5%	Southampton Ord.	99—102	77—79	..
120 000	,,	Feb. 12	7⅛	7⅛%	Tottenham { A 5 p.c.	135—138	120—123	..
782.275	,,	,,	6	5⅝%	District { B 3½ p.c.	115—117	89—91	..
181.255	,,	June 26	4	4%	4 p.c. Deb.	87—89	65—67	..
182 380	10	Dec. 30	5	—	Tuscan, Ltd.	5—6	1—2	..
149,900	10	July 1	5	5%	Do. 5 p.c. Deb. Red.	93—95	60—65	..
236,476	Stk.	Mar. 12	5	5%	Tynemouth 5 p.c. max..	108½—109½	91—92	..
					Wandsworth, Wimbledon, and Epsom—			..
30,000	,,	Feb. 26	8⅜	78/9	Wandsworth A 5 p.c.	151—156	117—122	..
255 636	,,	,,	6½	63/9	Do. B 3½ p.c.	129—134	101—103	..
108.075	,,	,,	5/17/3	55/1½	Do. C 3½ p.c.	110—115	88—93	..
352,000	,,	,,	6½	57/6	Wimbledon 5 p.c.	117—122	90—95	..
98,000	,,	,,	6⅜	63/9	Epsom 5 p.c.	121—126	98—103	..
88,416	,,	June 26	3	3%	3 p.c. Deb. Stk.	66—69	51—54	..

* Ex. div. † Paid on Old 10 p.c. and 7 p.c. Standard Stocks.

An Early Publication on Gas Lighting.

[From the "Observer" of 1817.]

Sunday, Jan. 26.] [*Price 7d.*

GAS LIGHTS.—Just published, price 2s., sewed.

OBSERVATION on GAS LIGHTS; being an impartial inquiry concerning the injurious effects on the health of the community from the use of coal gas for lighting the Metropolis. By CANDIDUS. Printed for the author, and sold by T. and G. Underwood, 32, Fleet St.

The Supply of Fertilizers.

In connection with the work of the Committee on Fertilizers, whose appointment was notified a fortnight ago, the following information was circulated in the Press last week: Special attention should be directed to the arrangements for the distribution in the rural districts of the necessary supplies of fertilizers. In recent years, the delays on the railways have been a just cause of complaint by farmers; and during the last two seasons the grievance has been greatly increased. The season will soon be on us; and unless prompt measures are taken, there will again be a position amounting almost to chaos on the railways, bringing inconvenience and loss to farmers. There may be a sufficiency of sulphate of ammonia at the gas-works, of basic slag at the grinding mills, of superphosphate at manure works, and of guano at warehouses; but those are not the places where the fertilizers are wanted. They are wanted at the farms; and arrangements should be made without loss of time to assure an ample supply of trucks for the distribution of the manure along the different lines to the stations from which the farmers can fetch it. In the autumn there was serious delay in the deliveries of basic slag; but the autumn demand for fertilizers is small compared with the quantities used in the spring. The matter is urgent; and requires prompt measures. As to the farmers, they should co-operate with the arrangements which may be formulated by the Committee; and they can best do so by reckoning out their requirements and sending in their orders without delay.

Increased Charges at Dukinfield.—At the last meeting of the Dukinfield Town Council, a recommendation of the Gas Committee that the price of gas be increased 4d. per 1000 c.ft. was approved. The reason for the increase is the higher payments to workmen for wages, and to contractors for supplies for gas making.

Wages at Brighouse.—The Special Wages Committee of the Brighouse Corporation, dealing with an application for advances through the Gas-Workers' Union, has recommended the increase of pay to all gas-works labourers from 32s. to 33s. per week; retort-house foreman, from 47s. to 50s. per week when the average daily make is 400,000 c.ft. or over, or alternative foreman stoker with pay at 6d. per shift more than stokers, and to share stokers' duties, but no boiler work; gas stokers, from 5s. 10d. to 6s. per eight-hour shift, double pay on Christmas Day if working, seven days' holiday per annum with pay, and 1s. per week war bonus; meter inspectors, from 33s. to 36s. per 49½ hour week, so long as present conditions (no gas-fitter being employed) continue; yard foremen, from 42s. to 45s. per week standing wage; retort setters from 41s. to 44s. per 49½ hour week; foreman fitter, from 43s. to 46s. per week standing wage, so long as a gas-fitter is unobtainable; blacksmith, from 32s. to 37s. per 49½ hour week, this to be retrospective to the date when the head blacksmith ceased duties; elevator men, 1s. per week above the works labourers; boiler man, increased to the same figure as gas stokers; lamp lighters to be paid at the same rate as works labourers.

South Staffordshire Mond Gas (Power and Heating) Company.

At the sixteenth ordinary meeting, to be held at Tipton on the 12th prox., the Directors will submit the report and accounts for the year ended Dec. 31. The report states that, in spite of every effort to maintain, and if possible increase, the supply of gas to satisfy a continuously growing demand, it has been found impossible to do more than nearly equal the previous year's output. Consequently, the Directors have been unable to supply the full quantities required by many consumers, or to connect-up any new customers. The shortage of plant, together with the inferior quality of the fuel obtainable, has caused the works to be continuously overdriven during the day time; and in order to safeguard the supply of gas to present consumers, and also supply several new firms who have asked for large quantities of gas, the Directors have submitted proposals to the Ministry of Munitions for extending the plant. Negotiations on this matter are proceeding. The Company became a controlled establishment early in the year. The continued difficulty in obtaining acid, owing to Government requirements, has caused a further reduction in the amount of sulphate of ammonia recovered. Further increases in wages were granted during the year. Since the war started, the cost of labour for production has increased by over 76 p.ct. The price of gas was increased; but the amount realized was not equal to the increased cost of manufacture. The gross profit for the year is £11,176, compared with £12,705 in 1915—a reduction of £1529. As the amount required for bank and debenture interest is £7702, the net profit for the year is £3474. In view of these circumstances, and the heavy bank overdraft, and the necessity for conserving resources, the Directors regret that they do not feel justified in recommending a dividend on the preference or ordinary shares. The Right Hon. Sir Alfred M. Mond, Bart., M.P., having accepted the office of First Commissioner of Works in the new Administration, has resigned his directorship of the Company. The Board have elected Mr. Herbert Alfred Humphrey, who has been closely connected with the Company since its formation, to fill the vacancy in the directorship. The meeting will be followed by a special general meeting, to consider the Bill which it is proposed to introduce into Parliament.

The Keighley Corporation War Bonus Committee recommend the granting of a war bonus of £5 4s. per annum to officials over 21 years of age whose salaries do not exceed £200, and of half of the amount to those under 21 years of age.

The Doncaster Corporation last week decided to make a further increase of 2s. per week in wages in all departments where advances have not been already dealt with. There has been a previous advance of 3s.; the new increase making a total advance of 5s.

The Directors of the Newcastle-upon-Tyne and Gateshead Gas Company have decided to recommend to the proprietors, subject to audit, the payment for the half year ended Dec. 31 of dividends at the rate of 4 p.ct. per annum upon the preference stock, and 4½ p.ct. per annum upon the ordinary stock.

An inquest was held at Elland, last week, in the case of John Thornton (aged 64), a labourer in the employ of Messrs. Robt. Dempster & Sons, Ltd., who sustained an injury while at work on the fixing of a new gearbox at the Elland Gas-Works, in April last year. He got something in his eye, but did not see a doctor until two days later, and subsequently the eye was removed. He afterwards became seriously ill, and died on Jan. 19 last. On medical evidence, the Jury returned the following verdict: "Heart failure—from dilated and degenerated heart—from septic inflammation of the eyeball, caused by substance entering his eye in the course of his work."

WANTED, FOR SALE, CONTRACTS, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Appointment Wanted.

SHOW-ROOM MANAGER. No. 6270.

Appointments, &c., Vacant.

WORKING MANAGER. No. 6286.
GENERAL FOREMAN. Devizes Gas-Works.
RENTAL CLERK. Cleethorpes Gas Company.
METER REPAIRER. Worthing Gas-Works.
GAS-FITTERS. Worthing Gas-Works.
GAS-FITTERS AND METER REPAIRER. Guernsey Gas Light Company.
GAS-FITTER AND A STOKER. Shirebrook Gas-Works.
FITTER. Nechells Gas-Works, Birmingham.
STOKER AND GAS-FITTER. Draycott Gas-Works.
STOKER AND A GAS-FITTER. Southwell Gas-Works.

Plant, &c. (Second Hand), for Sale.

AMMONIACAL LIQUOR STILL. Robin Hood Coke Works, near Wakefield.
GASHOLDER IRONWORK. Stockport Gas Department.
RETORT BENCH IRONWORK. Huddersfield Gas Department.
RETORT BENCH IRONWORK AND BRICKS. Motherwell Gas Department. Tenders by Feb. 17.

Meetings.

BRENTFORD GAS COMPANY. Caxton Hall, Westminster, Feb. 9. 2.30 o'clock.
SOUTH STAFFORDSHIRE MOND GAS COMPANY. Works, Dudley Port, Feb. 12. 2.45 o'clock.
SOUTH SUBURBAN GAS COMPANY. Cannon Street Hotel, Feb. 23. Twelve o'clock.

TENDERS FOR

Ammoniacal Liquor.
ALDERSHOT GAS, WATER, AND DISTRICT LIGHTING COMPANY.

Cookers and Grillers.
GLASGOW GAS DEPARTMENT. Tenders by Feb. 19.

Fire-Clay Goods.
WALLASEY CORPORATION. Tenders by Feb. 14.

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For GAS PURIFICATION.
LARGEST SALE OF ANY OXIDE.

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GAS PURIFICATION & CHEMICAL CO., LD.,
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Resists 4,500° Fahr. Best for Gas-Works.
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WET AND DRY METERS,
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SULPHATE OF AMMONIA SATURATORS and all LEAD and TIMBER WORK in connection with Sulphate Plants.
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SPENCER'S Patent Inclined HURDLE GRIDS.

THE very best Patent Grids for Holding Oxide Lightly.
See Illustrated Advertisement, on Nov. 21, p. 372.

BENZOL PLANTS FOR GAS-WORKS.

BAGLEY, MILLS, & Co., Ltd., 93, Victoria Street, Westminster, S.W., invite enquiries from all gas-works making 75 million cubic feet and upwards per annum.
See illustrated Advertisement Jan. 23, p. III. of Centre.

TAR DISTILLATION.

SUCCESSFUL and Up-to-Date Firm of Chemical Manufacturers would SUPERVISE the ERECTION and WORKING of a Limited Number of New Plants and undertake the Sale of Products on a Percentage Basis.
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ALDER AND MACKAY.
Jan. 29, 1917.

GAS-WORKS requiring Extensions should Communicate with FIRTH BLAKELEY, SONS, AND CO., LIMITED, Dewsbury, who make a Speciality of Catering for the Smaller Gas Concerns. Prices Reasonable; quality and results, the best. Satisfaction Guaranteed.

WANTED—A Position as Gas Company SHOW-ROOM MANAGER. Thoroughly Experienced in all Branches, and used to Control of Workmen. Several years with present Company. Change Desired. (Ineligible.) First Class References.
Address No. 6270, care of Mr. KING, 11, Bolt Court, FLEET STREET, E.C.

WANTED, immediately, One or Two GAS-FITTERS (ineligible). 8d. per Hour offered to Suitable Men.
Apply to SIDNEY O. STEPHENSON, General Manager, Gas-Works, WORTHING.

WANTED—Experienced Meter REPAIRER (ineligible).
Apply, stating Wages required, with *copies* of Testimonials, to SIDNEY O. STEPHENSON, Engineer and General Manager, Gas-Works, WORTHING.

GUERNSEY GAS LIGHT COMPANY, LIMITED.

WANTED—Several Good Gas-Fitters; also METER REPAIRER. Ineligible for the Army.
Applicants must state Age, previous Experience, and Wages required.
Office: Smith Street,
Guernsey, Jan. 15, 1917.

CLEETHORPES GAS COMPANY.

WANTED, Experienced Rental Clerk (ineligible). Salary (Commencing) £110 per Annum.
Applications to the SECRETARY, Gas Office, CLEETHORPES.

WANTED—A working Manager (Ineligible) for a 4 Million Works in Nottinghamshire. Must be good Carbonizer, Fitter, and able to do the Collecting.
Apply, by letter, with References, Wages required, and previous Experience, to No. 6286, care of Mr. KING, 11, Bolt Court, FLEET STREET, E.C.

SWINDON UNITED GAS COMPANY.
ENGINEER AND MANAGER.

APPLICANTS are Thanked and informed that THE POST HAS NOW BEEN FILLED.
E. GEO. VINCE,
Secretary.
Gas Offices,
Jan. 27, 1917.

WANTED—A Good-Reliable Stoker; also good, Experienced GAS-FITTER (Ineligible). Permanency.
Applications to the MANAGER, Gas-Works, DRAYCOTT, near Derby.

WANTED—A Good, Reliable Gas-FITTER, and Good STOKER (permanency), Both Ineligible for Army.
Apply, stating Experience and Wages required, to the MANAGER, Gas-Works, SHIREBROOK, near Mansfield.

WANTED—A Good, Reliable Stoker; also GAS-FITTER (permanency), Ineligible for the Army.
Apply to the MANAGER, Gas-Works, SOUTHWELL, Notts.

WANTED.—A General Foreman used to Regeneratives, Sulphate of Ammonia Manufacture, Control of Men, &c. House provided.
Apply, stating Wages required and Experience, with *copies* of Testimonials, not later than Feb. 5, to W. J. RENDELL BAKER, Engineer and Manager, Gas and Water-Works, DEVIZES, Wilts.

WANTED—A Fully-Qualified Fitter to look after Fiddes-Aldridge Charging Machines, Telphers, and Coal and Coke Conveyors. Standard Rate of Wages (47s. per Week) *plus* Bonus.
Apply, by letter, stating Experience, References, &c., to the ENGINEER, Nechells Gas-Works, BIRMINGHAM.

CAST-IRON Pipes for Sale—36 7 in. dia. by 9 ft. long, double Flanged, with Bends; also about 10 Tons of 4 in. Socket and Spigot PIPES. Immediate Delivery.
FIRTH BLAKELEY, LIMITED, Church Fenton, LEEDS.

GASHOLDER, 100,000 c. ft. Capacity, Columnless Type, nearly new, Two Lifts, New Steel TANK if required. Can be Inspected before removal.
FIRTH BLAKELEY, SONS, AND CO., LTD., Church Fenton, near LEEDS.

PURIFIERS, set of Four Luteless, 10 ft. square by 5 ft. deep. Set of Two 8 ft. square, Luteless. Four 6 ft. square Water Lutes. Cheap before removal.
FIRTH BLAKELEY, SONS, AND CO., LTD., Church Fenton, LEEDS.

FOR SALE—the following Tanks:—

STEEL TANK, about 21 ft. 6 in. diam. by 10 ft. deep.
" " " 31 ft. 6 in. diam. by 12 ft. 6 in. deep.
" " " 47 ft. 6 in. diam. by 10 ft. 6 in. deep.
Dome Covers for these if required from Gasholder Crowns.
Four CAST-IRON TANKS, 10 ft. square by 5 ft. deep, with Air-tight Covers.
One CAST-IRON TANK, 12 ft. 6 in. diam. by 10 ft. deep, Side plates only.
One Egg-end BOILER TANK 7 ft. by 30 ft.
One " " " 5 ft. by 35 ft.
One " " " 3 ft. 9 in. by 31 ft. 6 in.
Two Flat-end BOILER TANKS, 7 ft. by 30 ft.
One " " " 5 ft. by 30 ft.
One " " " 6 ft. 6 in. by 22 ft.
One " " " 5 ft. by 16 ft.
One " " " 4 ft. 4 in. by 15 ft.
GASHOLDERS, PURIFIERS, EXHAUSTERS, PUMPS, &c., also in stock.
FIRTH BLAKELEY, SONS, AND CO., LTD., CHURCH FENTON, LEEDS.